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ENVIRONMENTAL DEGRADATION: IMPLICATIONS FOR NATIONAL SECURITY

BY

MR. JOHN D. SCHLEGEL

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As the United States prepares to move into the 21st century, the threat of armed conflict between the United States and the Soviet Union appears to have receded into the realm of the improbable. At the same time, however, a new and perhaps more ominous threat is emerging to challenge the security of nations: environmental degradation. Burgeoning world populations and the quest for industrial/economic development have begun seriously to erode the capability of the earth's environment to sustain itself. The phenomena

(CONTINUED ON REVERSE)

of global warming, ozone depletion, deforestation, desertification and many forms of pollution are destroying the delicate life support systems upon which humanity depends for its very survival. National security, therefore, must be redefined and in this instance must be viewed in a context outside the traditional concept of military capability. This paper examines economic, social, political and military implications of environmental degradation as threats to the security of the United States and to world security. The paper concludes that a new level of international cooperation and technological innovation are required to reduce the negative impact of environmental degradation. An appendix provides additional data on specific forms of environmental degradation.

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ENVIRONMENTAL DEGRADATION: IMPLICATIONS FOR NATIONAL SECURITY

AN INDIVIDUAL STUDY PROJECT

by

Mr. John D. Schlegel

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U.S. Army War College
Carlisle Barracks, Pennsylvania 17013
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ENVIRONMENTAL DEGRADATION: IMPLICATIONS FOR NATIONAL SECURITY

CHAPTER I

INTRODUCTION

This paper will examine relevant data to determine that there is a direct and positive correlation between worldwide environmental degradation and U.S. national security interests. Building on this initial hypothesis, assuming a correlation, my intent is to determine also that the environmental degradation threat to security interests probably would increase in the next century. The results of my research through a significant amount of available information indicate the answer to the above questions is a resounding yes!

This answer alone, however, is insufficient for meaningful planning purposes. The specific environmental threat implications need to be determined and explored in the near term as well as prospects for a period well into the next century Attempting to forecast the future, particularly several decades ahead, is risky. However, there is sufficient scientific evidence to indicate the direction, and possibly the magnitude, of major environmental trends. With this environmental information, viewed in conjunction with expressed national interests, one can readily determine the points of confluence.

When the major security implications have been identified, realistic security planning can be accomplished effectively.

The major potential threat of East-West confrontation, characterized by massive conventional and nuclear arsenals possessed by opposing political/military alliances, appears to be on the decline. Within the past year the world has seen what may be the beginning of the disintegration of the Soviet empire. Economic and political revolutions in the Soviet Union and Eastern Europe, as well as other dramatic changes in Africa and Latin America, are upsetting many of the assumptions the United States has relied upon as a basis for its perception of world order. While the traditional East-West threat perceptions are fading, however, new and perhaps even more ominous threats are looming large on the horizon. These threats are a danger not only to the United States, but also to all the nations and peoples of the world. These are the threats posed by global warming, atmospheric ozone depletion, deforestation, reduction in biological diversity, desertification, and a wide range of pollution sources. Perhaps the greatest source of pollution is population itself -- people pollution - the population explosion.

Each of these environmental problem areas is examined in detail in the Appendix to this paper. However, while they are described separately, these environmental problem areas cannot be viewed in isolation. In fact, the primary cause for concern is the cumulative and interrelated affects of environmental degradation. Simply stated, there is a complex and downward spiraling relationship between man and his environment as

population growth exceeds the earth's capacity to accommodate. Environmental degradation is a physical manifestation created by man, but it impacts on man not only physically, but socially, politically and economically. The national security implications of environmental degradation derive, therefore, from this social, political and economic impact.

The view of environmental degradation as a function of national security interests as expressed above is considerably broader than the definition of "national security" provided by the Department of Defense Dictionary of Military and Associated Terms (JCS Pub.1) The "official" DoD definition of "national security" is:

> A collective term encompassing both national defense and foreign relations of the United States. Specifically, the condition provided by: a. a military or defense advantage over any foreign nation or group of nations, or b. a favorable foreign relations position, or c. a defense posture capable of successfully resisting hostile or destructive action from within or without, overt or covert. See also security.[1]

All three of the definitional elements, either singly or in combination, fail to consider the national security implications of environmental degradation. The elements are expressed in international terms which suggest a superior military response or capability, or an advantageous position relative to external nations. The definition does not consider the potential of a global threat, such as now being realized from environmental degradation, which transcends all national borders.

To understand environmental degradation as a security threat, one must, as expressed by Richard H. Stanley, President

of the Stanley Foundation, "move beyond traditional thinking." He describes the need to view "threat" in more abstract terms and that:

> This is especially true of so-called "global threats like global warming, ozone depletion, or loss of species. In these cases, there is no readily identifiable enemy; all too often the enemy is us. Second, we are in conflict with nature, not another nation or group. Third, the threat often has some degree of uncertainty, or seems distant -- another continent, or years, perhaps decades away.[2]

This paper accepts the threat of environmental degradation in Stanley's "beyond traditional thinking" frame of reference. It describes the security threat in a broad and "abstract" sense, but also identifies specific, and more traditional, potential threats to United States national security interests.

United States national security interests are derived from national interests. To understand the rationale for United States national security policy and strategy, one must look to an expressed statement of national interest. The United States' national interests were listed and defined in the President's January 1988 National Security Strategy of the United Sates. These interests include:

> the survival of the United States as a free and independent nation, with its fundamental values intact and its institutions and people secure; a healthy and growing U.S. economy to provide opportunity for individual prosperity and a resource base for our national endeavors; a stable and secure world, free from major threats to U.S. interests; the growth of human freedom, democratic institutions, and free market economies throughout the world, linked by a fair and open international trading system; and a healthy and vigorous alliance relationship.[3]

While not losing sight of the threat to these U.S. national interests represented by the military capability of the Soviet

Union, the greatest challenge to these interests in the future will probably come from environmental degradation. The increasing interdependence of the world's economies, considering the economic impact of resource depletion compounded by increasing demands from burgeoning populations and the Third World debt crises, will create additional stresses throughout the world economic system. Socially and politically, a new class of humanity, which one specialist in the field has described as "environmental refugees", will accelerate urbanization and cross-border migrations.[4] These environmental affects and their linkage to instability will directly challenge objectives of the U.S. national security strategy which includes statements calling for the U.S. "to respond to the challenges of the global economy...[and] to resolve peacefully disputes which affect U.S. interests in troubled regions of the world."[5]

ENDNOTES

1. U.S. Department of Defense, Dictionary of Military and Associated Terms (JCS Pub. 1), p. 244.

2. Report of the Twenty-fourth United Nations of the Next Decade Conference, Environmental Problems: A Global Security Threat, p. 10.

3. Ronald Reagan, National Security Strategy of the United States, p. 3.

4. Jodi L. Jacobson, Environmental Refugees: A Yardstick of Habitability, P. 5.

5. Reagan, p. 4.

CHAPTER II

HOW DID WE GET INTO THIS MESS?

Inventor-scientist James Lovelock has proposed an intriguing scientific theory to explain how the earth supports life. His concept, which he calls the Gaia hypothesis (after the ancient earth goddess of the Greeks) "...is that the planet is alive and functions as a superorganism in which living things interact with geophysical and chemical processes to maintain conditions suitable for life."[1] This hypothesis has generated significant interest in the scientific community, exemplified by the American Geophysical Union sponsoring a major conference in 1988 to consider the concept. The concept requires that the earth be considered holistically, as an ecosystem. Central to the thesis is the delicate balance, interrelatedness and mutual dependence among variables such as the atmosphere, temperature, oceans and the biosphere which determines the habitability of the earth.

As we enter the decade of the 1990s and approach the 21st century, the human race is massively impacting on the environmental balance. At the same time there is an increasing awareness of our degradation of the environment. Alarm is being expressed in scientific journals, in the mass media and by political activists. in 1988 TIME magazine featured earth as the "Planet of the Year", with the subtitle, "Endangered Earth." The magazine described in frightening detail what it called "Unprecedented profligacy in the name of progress."[2]

On one hand, there is a high sense of public awareness of what is being called the environmental crisis, but on the other hand, there is little concomitant direct action to address the problem. The U.S. Government, while providing public assurances of its commitment to environmental protection, has been very slow to provide resources or programs to combat environmental degradation within the U.S. and overseas. Strobe Talbott, writing for TIME magazine, noted that "The U.S. has spent several trillion dollars over the past 40 years buying insurance against a Soviet nuclear attack. Global warming, by contrast, is not just a risk but a certainty."[3]

The threat of environmental degradation has not been perceived as a major problem up to this time by the U.S. Government perhaps because its development and manifestations have not been as dramatic as other, more immediate crises or because the environment lacks a powerful constituency. The progressive, cumulative and insidious development of environmental degradation, however, is likely to become overwhelming if the U.S. and all the nations and peoples of the earth fail to address this issue directly.

While in fact the earth is now facing a crises of truly global proportions, environmental crisis are not new. Lester Brown and Pamela Shaw of the Worldwatch Institute of Washington D.C. point out that:

> Archaeological sites on every continent are littered with the remains of civilizations that were unable to cope with the forces of environmental degradation. The difference today is the rate and scale: pressure that once accumulated over centuries, or even millenia, are now compressed into decades.[4]

Referring to the rate and scale of pressure, the "Planet of the Year" issue of TIME magazine remarked that:

> Taking effective action to halt the massive injury to the earth's environment will require a mobilization of political will, international cooperation and sacrifice unknown except in wartime. Yet humanity is in a war right now, and it is not too Draconian to call it a war for survival...[man] finds himself at a crucial turning point: the actions of those now living will determine the future, and possibly the very survival of the species.[5]

While environmental degradation has now reached a point where people are becoming acutely aware of the environmental crisis, the warnings of the danger people now face were expressed as early as 1896 by the Swedish chemist Svante Arrhenius. He theorized that the rapid increase in the use of coal in Europe since the beginning of the Industrial Revolution would increase carbon dioxide concentrations in the atmosphere and cause a gradual rise in global temperature.[6] It was not until 1957, however, that scientific data presented in a study by the Scripps Institution of Oceanography tended to confirm Arrhenius' hypothesis. The Scripps study suggested that half the carbon dioxide released by industrial processes was being permanently trapped in the atmosphere.[7]

The International Geophysical Year, organized by the International Council of Scientific Unions and sponsored by the United Nations Educational, Scientific and Cultural Organization, also began in 1957. This "year" (actually eighteen months, from July 1957 to December 1958) of focused scientific study of the earth not only gathered information for further study, but also "...demonstrated conclusively that

world-wide scientific problems could be tackled successfully in this way and that,indeed, there was no other way to secure simultaneous world-wide observations of the upper atmosphere or the co-ordinated study of remote areas like the Antarctic."[8] This scientific effort was significant not only for the new insights it provided about the physics of the earth, but also because it established a precedent for international cooperation in earth science. At least 52 nations, including both the United States and the USSR, participated in this international effort - and this at the height of the Cold War![9] Certainly environmental degradation is a scientific problem which will require international cooperation to achieve any measure of success in moving toward a solution. The International Geophysical Year provides an excellent model for future international efforts to cope with environmental degradation.

While scientific study of the earth in the 1950s was beginning to quantify environmental degradation, the massive extent of pollution being created by industrialization and population growth started to become evident to the general public in the same timeframe. A United Nations Environment Programme publication cites just a few of the more significant instances of pollution "problems" becoming evident during the 1950s and 1960s, to include:

> the air pollution episode in London and New York between 1952 and 1966, the fatal instances of mercury poisoning at Minamata and Niigata between 1953 and 1965, the reduction in aquatic life in some of the North American Great Lakes the death of birds caused by the unexpected side-effects of DDT and other pesticides, and the massive oil pollution from the wreck of the Torrey Canyon in 1966.[10]

The publication of Rachel Carson's Silent Spring in 1962 further publicized the potential impact of pollution. In recognizing her contribution to the environmental movement, there currently is an internationally supported effort to award her posthumously a Nobel Prize.[11]

During the 1970s, international conferences at Founex, Switzerland, and Stockholm, Sweden, provided fora for the articulation of concerns about the environmental crisis. Primarily, the outcome of these conferences was the emergence of understanding of the critical relationship between development and the environment, and the need to practice "Ecodevelopment - a word coined to describe this process of ecologically sound development, of positive management of the environment for human benefit..."[12] While the conferences brought about greater recognition and some understanding of the environmental problem, the participating nations, however, failed to create an action plan or commit resources to the problems.

In spite of the conferences' recognition of the environmental crisis, the major driving factor behind the crisis, staggering population increase, continued unabated. In an attempt to put the population problem into perspective, one must first look back in order to look at the present and future. As recently as 1750, the world population was only 760 million. Between 1975 and 1985, the world population grew by 760 million.[13] Again, TIME magazine, in the "Planet of the Year" issue, dramatically expressed the population issue as "Ultimately, no problem may be more threatening to the earth's

environment than the proliferation of the human species. Today, the planet holds more than 5 billion people. During the next century, world population will double, with 90 percent of that growth occurring in the poorer, developing countries."[14] It is this asymmetric growth and the environmental degradation brought about by this growth, concentrated in the Third World, which, in my opinion, will cause the greatest threat to U.S. national security interests.

A three-year U.S. Government interagency study, The Global 2000 Report to the President, issued 24 July, 1980, provides an analysis and projection of the relative habitability of the world in the year 2000. A State Department document, Global Future: Time to Act, summarizes the Global 2000 report as follows:

> The Global 2000 report depicted a world "more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now." It projected that world population would increase from 4 billion to 6.35 billion in just one-quarter of a century; that the gap between rich nations and poor would widen; that per capita food consumption would rise somewhat worldwide -- but would not improve materially in the poor countries of South Asia and the Middle East, and would decline disastrously in Sub-Saharan Africa; that the real cost of food would rise everywhere; that the real cost of fuels would also rise everywhere and that fuelwood would fall far short of need; that currently productive grasslands and croplands would turn to desert-like conditions; that as much as 40% of the world's remaining tropical forests would be lost; and that as many as 20 percent of the species of plants and animals now inhabiting the earth could be extinct -- all by the end of the century.[15]

Of course the projections of the 2000 report were based on assumptions that the then (1980) present trends continue. Now, in 1990, there is little to suggest that humanity is doing

anything seriously to forestall the arrival of the world of the 2000 report.

I have attempted in this section to establish a frame of reference and background for understanding the enormity and complexity of environmental degradation problems. People are becoming aware of the issues, but awareness is only the first step to progress in effectively countering environmental degradation.

ENDNOTES

1. Eugene Linden, "How the Earth Maintains Life." TIME 13 November 1989, p. 114.

2. Thomas A. Sancton, "What On Earth Are We Doing?." TIME, 2 January 1989, p. 25.

3. Strobe Talbott, "Why Bush Should Sweat," TIME, 6 November 1989, P. 59.

4. Lester R. Brown and Pamela Shaw, Six Steps to a Sustainable Society, p. 6.

5. Sancton, "What On Earth Are We Doing?," p. 30.

6. Christopher Flavin, Slowing Global Warming: A Worldwide Strategy, p. 10.

7. Ibid., p. 11.

8. United Nations Environment Programme, The State of the Environment 1972-1982, p. 4.

9. Werner Buedeler, The International Geophysical Year, p. 25.

10. United Nations Environment Programme, p. 5.

11. Thomas A. Sancton, "Hands Across the Sea," TIME, 2 January 1989, p. 63.

12. United Nations Environment Programme, pp. 6-7.

13. Thomas W. Merrick, "World Population in Transition," Population Bulletin, April 1986, p. 3.

14. Anastasia Toufexis, "Too Many Mouths," TIME, 2 January 1989, p. 48.

15. U.S. Department of State, Council on Environmental Quality, Report to the President on Global Resources, Environment and Population, Global Future: Time To Act, p. x.

CHAPTER III

SECURITY IMPLICATIONS OF ENVIRONMENTAL DEGRADATION

In June, 1989, The Stanley Foundation, an Iowa-based international issues think tank, sponsored an international conference with the theme "Environmental Problems: A Global Security Threat". In his opening remarks, Richard H. Stanley, president of the Stanley Foundation, expressed the conceptual difficulty of equating environmental degradation with the common understanding of the term "security". In the introduction to this paper, Mr. Stanley is quoted as saying there is a need to "move beyond traditional thinking" in defining "national security". A more complete quotation of his remarks is warranted here to more fully appreciate the juxtaposition of the "traditional" and "beyond traditional" frames of reference. Mr. Stanley stated that:

> Traditionally, security is defined in national rather than global terms. National security is seen as a military issue, and there are several defining characteristics. First, there is the identification of an enemy or potential enemy. Second, there is the presence of a conflict of interests or goals. Third, there is a sense of urgency or immediacy to the threat. Together, these characteristics enable national leaders to ask people to make sacrifices - to go to war, or to raise taxes, or to forego domestic programs so as to keep a strong military.
>
> By contrast, we tend to think of international environment and resource depletion threats more abstractly. This is especially true of the so-called "global" threats like global warming, ozone depletion, or the loss of species. In these cases, there is no readily identifiable enemy; all too often the enemy is us. Second, we are in conflict with nature, not another nation or group. Third, the threat often has some degree of uncertainty, or seems distant - another continent, or years, perhaps decades away.[1]

These remarks, which provide an excellent perspective, still do not, however, address the essence of "security" within the new, "beyond traditional", thinking he advocates. Perhaps understanding of "security" is implied or assumed, but a more precise definition is essential for further development of the theme of security implications of environmental degradation. The Department of Defense Dictionary of Military and Associated Terms (JCS Pub. 1) defines "security" as:

> 1. Measures taken by a military unit, an activity or installation to protect itself against all acts designed to, or which may, impair its effectiveness. 2. A condition that results from the establishment and maintenance of protective measures that insure a state of inviolability from hostile acts or influences.[2]

This definition still does not capture the unique meaning of "security" within the context of environmental degradation as it is too restrictive and "defensive" in a military sense. A collegiate dictionary definition, on the other hand, expresses "security" primarily as "Freedom from risk or danger; safety" and "Freedom from doubt, anxiety, or fear; confidence."[3] Security as defined in this broad context comes closest to expressing the "global" nature of security from the "global" type of threat environmental degradation and resource depletion generates.

While the conceptual threats of "global" environmental degradation and resource depletion are relatively abstract, there is a more tangible threat, a threat deriving from the abstract which directly affects traditional U.S. national

security interests. This tangible threat exists at a level somewhere between the abstract and the more commonly understood threat of military-to-military confrontation. This section of the paper will address that tangible security threat which is induced by environmental degradation and the associated issue of resource depletion.

In the introduction to this paper, I stated it is my intent to determine if there is a direct and positive correlation between worldwide environmental degradation and U.S. national security interests. Further, I would attempt to determine, assuming there is a correlation, if the threat would probably increase as we move into the next century. (The appendix of this paper describes in greater detail the magnitude, complexity, pervasiveness and interrelatedness of the environmental degradation factors of population, global warming, ozone depletion, deforestation, desertification, pollution and reduction of biological diversity.) While examining the factors of environmental degradation it became apparent that while the phenomenon is an effect, it is also a cause. In my estimation, it is a cause of instability as it negatively manifests itself on the economic, social and political world order.

The remainder of this section of the paper describes how "global" economic, social and political arenas are destabilized through the influence of environmental degradation. While there obviously are trends of degradation, projections of degree, extent and impact are risky. A pessimist would probably focus

on "worst case" scenarios. The following analysis is intended to examine potential, without attempting to forecast.

ECONOMIC CONSIDERATIONS

Ecomonics is essentially the allocation of finite resources - supply and demand. Historically, it has borne a negative connotation, being referred to as the "dismal science". This reference was perhaps well deserved when considering what was thought to be the inevitability of abject poverty and misery at the "have not" end of the economic spectrum.

The destitution in Ireland, observed by Jonathan Swift in the early eighteenth century, moved him to write his satirical "A Modest Proposal" in which he suggested that infants born into poverty be sold to the wealthy for food. This arrangement, according to Swift, would have several advantages; it would provide income to the poor family, there would be one less mouth to feed in the poor family, and the wealthy could enjoy a gastronomic delicacy.[4]

In the nineteenth century, Karl Marx, seeing the abuses of capitalism with its exploitation of the working masses, wrote the philosophical basis for communism focused on a more equitable distribution of wealth.

While the world has progressed in many ways since the times of Swift and Marx, many of the same types of inequitable conditions still exist. Resources, both renewable and

non-renewable, are limited and the resource base is eroded by environmental degradation. Economic infrastructures, the relative scarcity of resources, and surging population growth can combine to create a world not far removed from the "dismal science" category.

After World War II, worldwide economic growth took off at an annual rate of about 4 percent. Sustained, this rate would lead to a 50-fold expansion of the global economy within a century with an associated increase in demand for resources.[5] Between 1960 and 1976, as the world population went from three billion to four billion, a threshold was crossed at which point "...human demands began to outstrip the sustainable yield of the basic biological systems that support the global economy."[6] Humanity is, therefore, currently on the side of the equation where there are more people than can be comfortably accommodated within existing resource constraints. To express this situation as an economic analogy, we can no longer live on the interest of our environmental legacy; to survive, we have begun, in a major and accelerating way, to spend the principal.

Environmental degradation threatens security by undermining the natural support system on which human activity depends. At the most basic levels for survival, these support systems must include the human needs for land, water and energy.

The earth's land surface is, for practical purposes, finite. With the earth's population increasing at a staggering rate, there is obviously less and less land to go around.

Arthur H. Westing of the Stockholm International Peace Research Institute, noted that:

> Humans have accommodated to the dilemma of a functionally shrinking global land area by concentrating into cities, by increasing the efficiency of their agriculture, by more heavily exploiting the ocean resources, by encroaching on the remaining areas of wild nature, and by conquering. ...As human populations and human aspirations have grown in a global land area that has long been fully divided among the nations of the world, one of the time-honoured approaches to alleviating the problem has been a resort to wars of conquest.[7]

Unfortunately, every one of these "solutions" further degrades the environment and can lead to instability. Urbanization and other migrations are presented under the topic - Social Considerations. Exploitation of the oceans has reached crisis proportions through a combination of pollution and overfishing, thereby further degrading this vital food source. At the same time, international conflicts have broken out over fishing in declared exclusive economic zones. Increasing the efficiency of agriculture can create its own environmental problems through the use of chemical fertilizers and pesticides. Encroaching on new areas can have disastrous economic consequences resulting from deforestation and desertification.

According to the United Nations Environmental Program, 35 percent of the earth's land surface - on which about one-fifth of the world's population depends for its livelihood - is threatened by desertification.[8] This phenomenon, noted earlier, results from population pressures and unequal land distribution which force people to overcultivate or overgraze limited land

holdings, or to attempt to open up new lands through deforestation, the cultivation of steep and erodible hillsides, etc..

Michael Renner of the Worldwatch Institute of Washington D.C., citing World Bank sources, claims that desertification in Africa has reached the level where "Food insecure people - those who do not have enough food for normal health and physical activity - number more than 100 million."[9] And of course, the more people attempt to scrape an existence from marginal lands, the process of desertification accelerates. In economic terms, when the supply of land becomes scarce and the demand is high, the price goes up.

One of the prices some people have been willing to pay for land is Westing's final response - to resort to conquest. We are all familiar with Germany's expressed need for "Lebensraum" as one of the justifications for World War II. More recently, the 1969 invasion of sparsely populated Honduras by densley populated and rapidly growing El Salvador can be attributed to the shortage of agricultural land in El Salvador.[10] Competition for scarce land will continue to be a destabilizing factor with national security implications.

Water, like land, is also essentially a finite and relatively scarce resource which is absolutely vital to human survival. Only 3 percent of the earth's water is fresh, and 75 percent of that amount is frozen in glacers and the polar ice caps.[11] The limited supply available is being severly taxed by

burgeoning populations, particularly in arid regions of the world. Extensive well-drilling is often used to attempt to acquire more water than that available on the surface. This practice, however, can have definite drawbacks when aquifers are drained faster than they can be replenished. Resulting surface subsidence can exacerbate flooding, particularly in river delta areas.

It has been estimated that 40 percent of the world's population depends for drinking water, irrigation, or hydroelectric power on the 214 major river systems shared by two or more countries; 12 of these waterways are shared by five or more nations.[12] Worldwatch's Renner notes that some of the problems encountered under these circumstances include:

> ...reduced water flow (and increased evaporation) through dams constructed by upstream riparian countries, water diversion, industrial and agrochemical pollution, salinization of streams through heavy irrigation, siltation of rivers, and floods aggravated by deforestation and soil erosion.[13]

Disputes among common water users that can lead to conflict are not surprising. An important cause of the Third Arab-Israeli War of 1967 was the struggle over the waters of the Jordan and other rivers in the area.[14] Also in the middle East, control of the waters of the Nile are much in dispute among Egypt, Ethiopia and the Sudan. The Egyptian Foreign Minister Butros Ghali warned early in 1985 that "the next war in our region will be over the waters of the Nile, not politics."[15]

Energy is the third essential ingredient in the economic

equation of survival. There are, of course, many potential and actual sources of energy. The fossil fuels (oil, coal and gas), unlike land and water, are not relatively fixed and finite, but rather, are quickly being consumed. The United States, with only 5 percent of the world's population, consumes about 26 percent of the world's oil.[16] I will not belabor the importance of oil to U.S. national security interests. But while the United States is now concerned about access to oil producing areas and security of lines of communication from oil fields to consumers, its concerns may become academic by the latter half of the next century when current proved reserves are long exhausted.[17] In the meantime, however, as U.S. and other industrialized country's oil dependence remains high and supplies dwindle, the potential for conflict should increase unless new energy sources are found or created.

As noted earlier, the threshold of biological sustainabliity was crossed between 1960 and 1976. In energy terms, this was the point where fuelwood was no longer being replaced by new growth. With relative scarcity, the price of fuelwood rose. This point is particularly significant in regard to the Third World where fuelwood frequently is the only source of energy available. In the short term, oil products became a reasonable substitute for fuelwood. Oil price increases in the early 1970s, however, drove oil out of the reach of millions. One commentator noted that:

> In some Third World countries the cost of firewood climbed almost as fast as the price of kerosene over the past

> decade. This often translates into a decline in the standard of living for both urban and rural dwellers, many of whom must trade off the cost of the food they eat against the cost of the fuel to cook it.[18]

The cost of fuelwood, or other energy sources, is just one example of the impact of resource depletion and environmental degradation, particularly on Third World populations. Taken together, these factors can have a devastating effect on economic health.

In considering the potential for economic crisis stemming from environmental problems, Alan B. Durning of the Worldwatch Institute stated:

> In 1984, the livelihoods of 850 million people were estimated to be at risk due to desertification. In 1980, acute fuelwood shortages were estimated to afflict 100 million. Some 500 million of the world's highland residents are in jeopardy from soil erosion and deforestation...If climate changes, soil erosion, deforestation, and population growth continue along their current trajectories, the poverty rate will almost certainly skyrocket, perhaps doubling worldwide by the second half of the next century...[and] half of humanity could be living in absolute poverty some time between 2050 and 2075.[19]

To compound this dismal economic possibility further, the issue of massive debt looms large which further stacks the deck against the Third World. The debt crisis had its origins in the oil price increases of 1973 and 1979, when oil exporting countries put much of their new earnings in the banking systems of industrialized countries. Flush with new money, the banks were eager to lend to Third World countries to finance new, and sometimes ill-conceived, development projects. During the

1980s, the industrialized nations tightened credit to fight inflation, and drove up interest rates. At the same time. earnings from the export of commodities dropped, particularly in relation to the costs for imports from industrialized countries. The result is a situation where the Third World is caught between rising debt and falling earnings. The economic bottom line is that in 1989, the Third World owed $1.2 trillion - nearly half of its aggregate GNP, to industrialized country's banks and governments.[20]

The combination of debt service, increasing costs for manufactured goods, falling prices for export products, rapidly growing populations, grossly inequitable distribution of wealth. depletion of resources and environmental degradation has created in many areas of the Third World an atmosphere of desperation. Environmental degradation alone is not responsible for this economic chaos, but it is a major contributor. Any effort to reverse this economic downward spiral must address the environmental question.

While the Third World is the area where the affects of this unfortunate combination of economic factors are most dramatic. the extent and impact of environmental degradation knows no boundaries. The rush for industrialization and economic development throughout the world has seriously undermined the ability of the earth's life support system to sustain itself. The tightening interdependence of the world's economies, and the truly global nature of environmental degradation, do not allow

the United States the luxury of standing aside.

The security implications of these economic circumstances must not be underestimated. Heightened instability will surely result from increasing competition by growing populations for decreasing supplies of both renewable and nonrenewable resources. The misery of marginal existence cannot be ignored.

SOCIAL CONSIDERATIONS

Environmental degradation is essentially a physical phenomenon. Discussion of this concept has focused primarily on physiological changes to the atmosphere, the oceans and the land surfaces of the earth. These changes are being brought about by pollution of many types, and exhaustion of resources. The most significant impact of environmental degradation, however, is on people. It is the impact of the phenomenon on people that puts the problem into perspective and ascribes its particular relevance as a national security threat.

Entering the last decade of the 20th century, humanity finds itself in a situation where 40,000 babies in the Third World die of starvation each and every day.[21] For this to occur, humanity now appears to be out of balance with both the earth's life support system and its values. Frequently, Third World government policies or incompetence exacerbate social problems resulting from environmental degradation by their attempts to impose their will on desperate people by inhibiting

or prohibiting the distribution of available food or otherwise trying to manage their populations. As populations continue to increase, however, the imbalance can only worsen as will mans' inhumanity.

This section of the paper examines some of the more direct and most probable consequences of environmental degradation on people. The social impact of population growth is addressed, as well as the cause and affect of environmental refugees and urbanization. The security implications of social change, much of it driven by environmental degradation, are also presented.

Statistics and projections about the earth's population are presented in the appendix of this paper. Among the data in the appendix it is noted that the current population of about 5.2 billion would probably double at some point in time during the next century. Further, it is noted that 90 percent of this projected growth would occur in the less developed area of the world, principally Latin America, Sub-Sahara Africa and Asia. These estimates are based on population variables which include fertility, mortality, migration, size, composition and distribution.[22] Accurate data on the population variables and an understanding of the interrelationships among them are needed in order to forecast fairly accurately the population future.

Problems related to population growth can also be fairly accurately forecasted, although not to the degree of precision one could expect with numbers. Looking subjectively at problems

created by population growth, James E. Harf and B. Thomas Trout of Duke University use word equations to describe what they believe are five basic population growth problems. These are:

1. Large Population Size + Limited Arable Land = Food Shortage, Starvation and Malnutrition

2. Large Population Size + limited Resource Base = Handicap to Improving Living Standard Through Industrialization

3. Rapid Population Growth + Low Level of Economic Development = Population "Stumbling Block" to Rapid Development

4. Very Young Population + Limited Public Funds = Difficulties in overcoming Illiteracy, Improving Health Conditions, and Increasing Economy

5. Rapid Population Growth + Low Level of Industrialization = Unemployment and Political Instability [23]

These five word-equations put into perspective the fundamental requirement for a growing population to have adaquate arable land and an adequate resource base. But as the world population continues to grow, environmental dergadation is progressively destroying both arable land and the resource base. With less than the minimum requirement of these two essentials, the logic of the equations suggest political instability will be a result.

In The Grapes of Wrath, John Steinbeck graphically describes the impact of environmental and economic deterioration on the farmers of the Great Plains during the 1930s. Granted, the Depression was instrumental in making life difficult for the farmers, but ultimately it was the creation of the "Dust Bowl" by a combination of unsustainable farming practices and drought, which drove them from the land and seek better living conditions

in the West.[24] These American farmers were environmental refugees. Living conditions became intolerable and they had to leave their land in order to survive.

While neither the U.S. State Department nor the U.N. High Commission for Refugees consider "environmental refugees" an official category and therefore have no statistics, Jodi Jacobson of the Worldwatch Institute estimates there are at least 10 million environmental refugees, nearly the same number as officially recognized refugees.[25]

Like Steinbeck's "Okies", millions of people today are living on the edge of survival. Poverty itself becomes a cause of environmental degradation as people overexploit their limited resources by sacrificing the future to try to salvage the present, only to see the winds and rain carry away their efforts. The dynamics of desertification are described in the appendix to this paper. Only by experiencing, however, the frustration and desperation of the farmer fighting to exist, and losing, could one appreciate the driving force of desertification. The deterioration of the land allows little alternative other than to seek improved conditions elsewhere. And then the self-sustaining downward spiral of economic deterioration and environmental degradation perpetuates itself as the cycle is repeated.

Another type of environmental refugee is one who has been displaced by inundation of the land by rising waters. The appendix to this paper provided the specifics of global warming

with its thermal expansion of water and gradual melting of the polar ice caps. In a reportedly emotional speech before the United Nations General Assembly in October 1987, Maumoon Abdul Gayoom, President of the Maldives, declared that a one meter sea-level rise would jeopardize the very survival of his 1,196-island nation.[26] Unfortunately, by the end of the next century, the sea level is predicted to rise by 1.4 to 2.2 meters.[27] If this sea-level rise occurs, the Maldives, along with several other areas such as the Pacific islands of Kiribati, Tuvalu, and the Marshalls could simply disappear.[28]

The problem of rising seas is exacerbated in many instances by concommitant subsidence of river deltas and deforestation of mountains. This combination of factors provides all the ingredients for catastrophic flooding in some of the areas of the world with the highest population concentrations. Several researchers at Woods Hole Oceanographic Institute have prepared a study which examines the impact of sea-level rise on both the Bengal and Nile river deltas. The implications of their findings are frightening. Looking first at the Bengal delta under what the researchers called their "really worst case" by the year 2100, 34 percent of the habitable land of Bangladesh would be under water which would displace 35 percent of the population - or about 38 million people. Similar analysis of the Nile delta shows that by 2100, 26 percent of the habitable land would be inundated, with 24 percent of the Egyptian population displaced.[29] While granted, these figures represent

"worst case" analysis, even smaller levels of sea rise would still have major consequences for the people of these and other regions of the world.

A third class of environmental refugee would include people displaced by pollution - both chemical and nuclear. The Love Canal toxic chemical dump case in the United States, while highly publicized, displaced only 1,390 families.[30] While this incident is certainly distressing, the problem appears to be considerably worse in Eastern Europe and the Soviet Union. In Poland, for example, the government declared the village of Bogomice and four others "unfit for human habitation" due to the extremely high levels of heavy metals in the air and soil coming from nearby copper smelting plants. The Polish government is in the process of moving people out of the area.[31] And in the Soviet Union, the Chernobyl nuclear accident forced the evacuation of more than 100,000 people, while an area of 2,600 square kilometers was made uninhabitable.[32]

The problem with all environmental refugees, of course, is what happens to them after they have been forced to leave the environmentally devastated land they once called home. Commenting on the inevitable plight of many in Bangladesh, Jodi Jacobson of the Worldwatch Institute asked the question:

> Where will those displaced by rising seas go? Moving farther inland, millions of environmental refugees will have to compete with the local populace for scarce food, water, and land, perhaps spurring regional clashes. Moreover, existing tensions between Bangladesh and its large neighbor to the west, India, are likely to heighten as the certain influx of environmental refugees from the former rises. Eventually, the combination of rising seas,

> harsher storms, and degradation of the Bengal delta may wreck so much damage that Bangladesh as it is known today may virtually cease to exist.[33]

From the above comment one can see the potential for this type of conflict arising in many areas of the world. In an ever more crowded world, milions of people will be driven from the land by desertification, inundation or pollution. As the relative size of the earth's habitable land surface actually shrinks, many of the environmental refugees, in order to survive, will move into cities which are already overcrowded. The future for these people is not very bright.

The United Nation Environment Program (UNEP) has estimated that at this time about 35 percent of the earth's land surface, home to more than 850 million people, is in various stages of desertification, with about 135 million people living in areas which are severly degraded.[34] A UNEP report notes that:

> Throughout the Third World, land degradation has been the main factor in the migration of subsistence farmers into the slums and shantytowns of major cities, producing desperate populations vulnerable to disease and natural disasters and prone to participate in crime and civil strife, [and that] such exodus...exaberate[s] the already dire urban problems.[35]

Perhaps the best (worst?) example of this situation occurred in the Sahel region of Africa which is suffering acutely from desertification. Major droughts over the past two decades, accelerating desertification, have forces 20 percent of the population of Mauritania and over 1 million people in Burkino Faso to migrate to cities.[36]

Urbanization is the dominant demographic trend of the late

20th century. At the current rate of population growth and concentration, more than half the people of earth will live in urban areas shortly after the turn of the century.[37] Latin America, with some of the worlds largest cities (Mexico City - 20 million, Sao Paulo - 14 million) is already well ahead of the global average with 65 percent of its people now living in cities, and where three-fourths, or about 422 million, of its people will live in just ten years.[38]

Cities are more than just a large concentration of people. Cities have become complex, highly interdependent and functionally specialized social systems. Historically, as well as today, cities serve a positive function as centers of government, education, culture, finance, manufacturing and trade. To function effectively, however, cities must maintain some degree of equalibrium among all the various, as well as essential, components and the infrastructure.

The current unprecedented rate of growth of cities, particularly in the Third World, in both population and geographic area, is tending to unbalance the equalibrium, and the largest cities are becoming dysfunctional. With the large influx of rural poor (many of them environmental refugees) and a rapid rate of natural increase, the annual urban growth rate in the Third World is 3.5 percent - more than triple that of the industrial world.[39] This growth rate is outpacing the ability of cities to provide for their people food, housing, water, electricity, transportation, education, sanitation and public

safety.

Perhaps more important, the cities are unable to provide employment for a major portion of their populations. In Manila, for example, 16 percent of the labor force is unemployed and 43 percent is underemployed.[40] Alan B. Durning of the Worldwatch Institute, using World Bank figures, noted that nearly one-half of the people living in Latin American cities are living in "absolute poverty."[41] Much of this problem in the Third World is driven by debt-induced hyperinflation and economic stagnation which has resulted in the economic polarization of society.[42] The handful of the rich control an ever larger share of the economy, while the poor slide into abject poverty. This is the world the majority of environmental refugees will find when they are driven from the degraded land and have nowhere else to go but to the already overcrowded cities. Any expectations they may have for the "good life" in the city will be quickly dashed.

The living conditions of the poverty stricken masses in the teeming cities of the third world are abominable. An observer described the barrio of Morelos, near Mexico City's central square as:

> a vast warren of dusty, potholed streets and narrow entryways. The passages lead to a gloomy world. On each side of a roofless patio is a ten-room jumble. Each room holds a family; each family averages five people. The only bathrooms - two to serve 100 people - are located at the back of the patio. The odor of grease and sewage permeates the air. Flies buzz relentlessly. The people who live here are considered lucky...In the shanty towns on Mexico City's outskirts, tens of thousands of people shelter in huts made of cardboard with aluminum roofs. There is no running water and no sanitation. The stench is overpowering; garbage and human waste heap up in piles.

Rats roam freely, like stray domestic animals.[43] Attempting to find food in this kind of a world becomes a major preoccupation. Between 1981 and 1986, more than a dozen food-related riots and demonstrations have occurred in urban areas throughout the world.[44] Medical problems abound with respiratory infections, brought on by household environmental problems like leaky kerosene stoves, being the most frequent.[45]

One of the major themes when considering the social consequences of environmental degradation must be the potential for social disintegration leading to conflict. Environmental refugees are exposed to an often lengthy continuum of stress as they are forced through the process of being driven from their traditional homelands and migrate to other marginal agricultural areas or into the urban centers. The sense of community with family, friends and neighbors, as well as the bond with what has become the degraded soil, are weakened or destroyed. Along with this sense of loss of traditional ties will be an erosion of traditional values and social constraints. The next step in the process is described by Konrad Lorenz in his major work <u>On Aggression</u> in which he states:

> To kill a culture, it is often sufficient to bring it into contact with another, particularly if the latter is higher, or is at least regarded as higher...The people of the subdued side then tend to look down upon everything they previously held sacred and to ape the customs which they regard as superior. As the system of social norms and rites characteristic of a culture is always adapted, in many particular ways, to the conditions of its environment, this unquestioning acceptance of foreign customs almost invariably leads to maladaption.[46]

To take Lorenz's "maladaption" one step further, Kelly and Galle expressed in Sociological Perspectives and Evidence on the Links Between Population and Conflict that:

> Massive and/or rapid changes that physically place individuals or groups in new environments and expose them to unfamiliar ideas, norms, and cultures (or subcultures) may create collective disorganization or bewilderment. This disorganization or bewilderment may lead to collective discontent which in turn may lead to collective violence or conflict.[47]

The process of social/cultural disintegration, therefore, which began in being driven off the land, would be completed by exposure to the new world of urban shantytowns and the deplorable living conditions already described, and characterized by a tendency towards violence.

The urban slum represents perhaps the essence of the affects of "people pollution" and the population explosion. In addition to the filth and poverty of the slums, probably the most pronounced characteristic is crowding. The sociological impact of crowding must not be underestimated, as it is reinforcing of the tendency toward violence resulting from dislocation. Lorenz points out "That crowding increases the propensity to aggressive behavior has long been known and demonstrated by sociological research."[48] This response is brought about primarily by both incessant interpersonal social demands (stimulus overload), and lack of control over one's interpersonal space, or lack of privacy.[49]

Nazli Choucri, in his Multidisciplinary Perspectives on Population and Conflict notes the need to distinguish between

conflict at the interpersonal level and conflict at the intergroup levels. He further states that:

> The complexity of population dynamics - population size, composition, distribution, and change - are paralleled by the complexity of conflict dynamics in terms of the various levels of conflict and ways in which hostilities can be manifested.[50]

There is, therefore, no direct and positive correlation between population dynamics on one side, and conflict, either by degree and/or type, on the other. The complexities of each unique setting will determine the conflict characteristics, if any, stemming from a particular population environment. At the same time, there is sufficient evidence to indicate there is a strong propensity for conflict of some sort resulting from the rapid change and overcrowding of populations. This uncertainty associated with possible conflict outcomes makes it more difficult to predict instability and, therefore, more difficult to plan for coping programs.

The social considerations of environmental degradation are of major proportion and complexity. The long range implications of the destruction of land through desertification, inundation or pollution will be determined by the reactions of the affected people, both those forced to move and those in the receiving areas. The cities of the future, particularly those in the Third World, will have significant potential for social instability. More rural areas will likewise be impacted by environmental refugees as the competition for scarce resources becomes ever more acute. As the reality of social consequences

become more apparent, reaction is most frequently expressed in the political sphere.

POLITICAL CONSIDERATIONS

The economic and social consequences of environmental degradation ultimately manifest themselves in political considerations. The spectrum of political response ranges from the individual to the international level, and includes both political conflict and political activism at all levels. The discussion in this section of the paper focuses primarily on political conflict potential as the baseline for determining the security implications of environmental degradation. The political activism issue, however, is the other side of the political coin and the two issues must be considered together and in context.

There is a miltitude of potential points of political confrontation stemming from environmental degradation in its broadest sense. At the root of potential conflict, however, is the current political organization of the world and the uneven distribution of degradation impact. Our Common Future, the report of the World Commission on Environment and Development (the Brundtland Commission) expressed that:

> The Earth is one but the world is not. We all depend on one biosphere for sustaining our lives. Yet each community, each country, strives for survival and prosperity with little regard for its impact on others.[51]

The political boundaries of sovereign states mean nothing in the dynamics of environmental degradation. Environmental degradation is a transnational phenomenon and, therefore, can lead to international conflict.

Several examples of the interrelatedness of environmental degradation factors and transnational consequences have already been cited. Bangladesh exemplifies the confluence of the variables of global warming, deforestation and delta subsidence with the resultant creation of significant numbers of environmental refugees migrating across political borders. Desertification of the Sahel in Africa has driven hundreds of thousands of people across national boundaries. The critical role of water, and the competition for control of scarce water resources in watersheds shared by two or more countries has significant potential for generating conflict. The impact of unprecedented population growth and resultant "people pollution" is already becoming a major international problem.

Many of the transnational affects of pollution have also been described, ranging from Chernobyl's radiation spreading across Europe, to acid rain, resulting from industrial processes in the United States, killing forests and lakes in Canada. And, of course, the truely worldwide conditions of global warming and ozone depletion are, or will, impact on everyone. As early as 1972, however, the United Nations Conference on the Human Environment declared that all states have the responsibility to ensure that activities within their jurisdictions or control do

not cause damage to the environment of other countries.[52] This UN declaration, however, seems to carry little weight.

Behind many of these transnational environmental problems are the unequal distribution of economic/industrial activity and unequal population distribution superimposed on a system of sovereign states. In this time of ever-increasing economic interdependence and political multipolarity, the reality of nation states, although perhaps becoming anachronistic or at least much less influential, is still very much with us.

Each sovereign government, in its own way, is attempting to provide for its citizens the benefits of a higher standard of living and security from external threats. Simply put, self interest usually supersedes common interest if the two come into conflict. Sovereignty is something very reluctantly relinquished. When it comes to international cooperation to find solutions to environmental problems, nations frequently are much more supportive with rhetoric than they are with programs which may infringe on their national sovereignty but which could realisticly deal with the problem. Examples of this type of national behavior were described by Michael Renner of the Worldwatch Institute when he pointed out that;

> At a conference of European environmental ministers to work out a cleanup program for the Rhine, France, Switzerland, and West Germany objected to a Dutch recommendation for international inspection of suspected pollution sites. arguing it would violate national sovereignty. West Germany similarly refused to consent to a proposal that would have entrusted the Secretariat of the United Nations Economic Commission for Europe with inspection of sources of sulfur dioxide pollution in Europe. Brazil, suddenly exposed to international pressure to halt the destruction

> of the Amazon rain forest, successfully resisted the proposed formation of an international environmental agency that it feared could intervene in what it sees as its internal affairs.[53]

The European examples speak of the difficulty of getting the advanced countries of the European Economic Community to work together to solve common environmental problems. The Brazilian example opens up a much more difficult problem; the North-South issue.

In order for the developed nations of the world to reach their relatively advanced economic/industrial state, they had ready access to raw materials, a skilled workforce and some system for creating an industrial infrastructure. Today's economic/industrial front-runners got to the top in many cases by exploiting natural resources in what is now referred to as the Third World, by consuming tremendous amounts of energy, and polluting their own environment. In the year 1987, the United States created 5.03 tons per capita of carbon emissions to sustain its standard of living. Brazil and Zaire, on the other hand, produced .38 and .03 tons per capita of carbon emissions respectively.[54] These figures speak for themselves. In referring to the disparity of development between North and South, Mostafa Tolba, executive director of the United Nations Environment Program stated that;

> If the developing nations, home to 8 out of 10 people, repeat the pattern of development of the North, if they reach the North's levels of consumer goods and fuel consumption, and they continue to clear the forests, then our mutual destruction is assured.[55]

We now seem to find ourselves in an ironic world where the developed nations of the North are self-righteously pressuring the less developed nations of the South to join in the fight against environmental degradation. The Stanley Foundation conference report on Environmental Problems: A Global Security Threat noted that:

> Environmental concerns as portrayed in the Northern media do not reflict a worldwide concern over the environment. Too often, Northern media emphasize environmental problems in the South, ignoring egregious pollution in the North. It is politically easier to ask someone else to change lifestyle than to change one's own. Some participants noted that living in harmony with nature is not a novel concept in many of the poor countries in Africa. They pointed out that past Northern economic compromises with the environment have been responsible for much of the environmental misery that now afflicts many poor nations. They noted that for many corporations, environmental degradation is a business decision, but for the poor in developing countries it is an unhappy choice driven by the need for individual survival.[56]

It becomes easy, therefore, to understand why the South has some difficulty in coming to grips with the environmental issue. When the South is burdened with massive external debt servicing to the North, and at the same time is struggling to deal constructively with major social and economic problems at home the environmental issue comes down to one of priority.

The irony of the North-South conflict of environmental perspective is compounded when one considers the evolving state of East-West relations. For four decades the ideological split of East and West dominated the political environment. Now, East-West awareness and cooperation on mutual environmental problems is reaching new heights and appears to be a factor in

further reducing the ideological split as the East-West nations recognize a common bond. Environmental cooperation between East and West was formalized by the 1979 Convention on Long-Range Transboundary Air Pollution.[57] West Germany, because of its central location in Europe, has much to gain through East-West cooperative environmental efforts. In spite of the earlier documentation of West German reluctance to cooperate on environmental issues within western Europe because of a perceived threat to its sovereignty, West Germany has led in East-West environmental rapprochement. According to Helmut Schreiber of the Institute for European Environmental Policy in Bonn, West Germany is a party to 70 to 80 percent of the approximately 100 bilateral environmental agreements between Eastern and Western European countries.[58]

At the very time, therefore, that environmental tensions between North and South are increasing, the East-West relationship is improving. In a speech to the United Nations General Assembly, Soviet Foreign Minister Eduard Shevardnadze commented that "the biosphere recognizes no divisions into blocs, alliances or systems. All share the same climatic system and no one is in a position to build his own isolated and independent line of environmental defense."[59] The rhetoric is very positive, but the Soviet Union, one of the worst polluters, is not backing up words with action. The Soviets, for example, refused to go along with the chlorofluorocarbon (CFC) phaseout proposed at the 1989 London ozone conference, and up to this

point they have failed to make a significant commitment to reduce their contribution to global warming.[60] Of course the reality is that the countries of the industrial north, both East and West, have more in common than the North-South split.

A significant factor in the development of environmental awareness and consensus has been the rise of the "Green" movement. "Greens" are special interest groups or political parties with a platform of environmental activism. Historically, conservationists in the United States have had mixed results holding back the tide of development and protecting wilderness areas. With heightened worldwide interest in the environment, however, the role and influence of environmentalists seems to be on the rise. One measure of this increase is the fact that worldwide membership in environmental groups expanded from 13.3 million in 1988 to 15.9 million in 1989.[61]

In Europe, in particular, the "Greens" have gone beyond vocal activism and in some instances have formed political parties. Since 1983, "green" parties have won seats in national parliaments in West Germany, Sweden, Austria, the Netherlands, Belgium, Switzerland, Finland, Portugal and Italy. While most of these groups are more effective in pressuring larger political parties of the Left and Right into environmental positions, the West German "greens" are well established at both local and national levels and comprise between 7 and 10 percent of the electorate.[62]

The "green" movement is not limited to Europe. Bahaddin Bakri, a professor of urban ecology at Cairo University, has organized a "green" party to work toward a lessening of the population explosion and environmental degradation afflicting the Nile river valley. As of May 1989, however, the Egyptian government refused to recognize the "greens" as a political party on the grounds that it would "threaten the nation's socialist gains."[63] Other fledgling movements, however, are surfacing in the Third World as well as the developed world.

In the western industrial world, environmental consciousness has finally reached the center of geopolitical attention, if not action. The leaders of the Group of Seven industrial democracies (United States, Japan, Britain, West Germany, France, Italy and Canada) met in Paris in July 1989 for their annual economic summit and devoted one-third of their final communique to environmental considerations. Like the Soviets before, however, the communique was long on rhetoric and short on substance. It called for "decisive action" to "understand and protect the earth's ecological balance", but, to quote the New York Times, "While expressing concern, and at times alarm, about the environment, the leaders from Western Europe and North America fell short of making any firm commitments to remedy the situation."[64]

Political implications of environmental degradation are particularly difficult to isolate. They flow from the social and economic consequences of environmental degradation and get

tangled in the concept of national sovereignty. The leaders of the Group of Seven are painfully aware of this difficulty. The environmental degradation issues appear to be aligning into a North-South confrontation which will have national security implications for the United States.

MILITARY CONSIDERATIONS

A listing of the United States' national interests are provided in the introduction section of this paper. Threats to our declared interests are significant. The Soviet Union retains a capability to threaten the very survival of the United States as well as challenge U.S. interests in other parts of the world. Additional threats to U.S. interests include regional conflicts and terrorism. The remaining threats, as expressed in the January 1988 National Security Strategy of the United States focus on elements which in many cases derive from burgeoning population and environmental degradation problems. These threats include:

> The hard currency debts of many developing nations - including several that are neighbors and important friends and allies of the United States - have had severe and destabilizing consequences within their societies. Most of the debtor states have been unable to achieve sustained and significant growth since the early 1980s and have experienced high rates of unemployment and inflation, and extended periods of unpopular austerity. Many of these countries are also adversely affected by low commodity prices in the international market, capital flight, excessive government spending, narcotics production and trafficking, and other indigenous and externally imposed problems that will not be easily remedied. The longer the economies of the major debtor states fail to rebound from

> these conditions, the greater are the possibilities that irresponsible elements will gain local support for nationalistic responses that could damage important U.S interests.[65]

The document continues with more specific references to environmental degradation and population issues and cites:

> Critical shortages of food, a lack of health services, and inabilities to meet other basic needs will keep millions of people, particularly in Africa, in peril. The dangerous depletion or contamination of the natural endowments of some nations - soil, forests, water, air - will add to their environmental and health problems, and increasingly to those of the global community. These problems cannot be resolved simply through outside assistance, for many of them will require policy changes and leadership by governments and elites in the countries themselves. But all create potential threats to the peace and prosperity that are in our national interest, as well as the interests of the affected nations.[66]

These above lengthy quotations highlight economic threats and environmental/population threats but fail to make the linkage between the two. They also place the threats external to the United States, and fail to recognize the threat, particularly environmental, from within. These omissions suggest there is perhaps less than full understanding and appreciation at the senior levels of the U.S. Government of the significance of the causes, affects and interrelationships of environmental factors. The national security threats as expressed in the 1988 document, however, are valid and need to be realistically addressed.

Current DoD environmental policies and programs are stated in the 1990 Annual Report to the President and the Congress prepared by the Secretary of Defense. The two primary

environmental objectives expressed in the report are "protecting long-term access to the air, land, and water needed to sustain mission capability, and enhancing the quality of life and the environment."[67] What are identified in the report as "major actions already under way" include:

> Some 900 installations have been surveyed to date, and more than 8,000 potentially contaminated sites have been identified. Another 7,000 sites on formerly used DoD properties are being reviewed.[68]

But all of these "actions" are paper exercises. The terms "surveyed", "identified", and "reviewed" do not instill a significant level of confidence that anything substantial will be done to clean up existing or former DoD facilities. And the above numbers say nothing of the potential number of contaminated DoD sites both in the United States and overseas.

The DoD, and its agent the Department of Energy (DoE), have been responsible for some of the worst forms of pollution and environmental degradation. The production of nuclear weapons results in "enormous" amounts of hazardous and radioactive waste.[69] When nuclear weapons reach their "shelf life", they are taken out of service and the nuclear material can then be "reprocessed" to recover useful material, but this process also generates radiation hazards.[70] Nuclear propulsion systems of many submarines and major surface combatants also produce the inevitable by-product of nuclear waste. All this nuclear waste must be disposed of safely, and for practical purposes, for eternity. The current cost estimate for environmental clean-up

of DoE weapons production facilities is between $35 and $65 billion.[71]

Of course, if nuclear weapons were ever used in a major exchange, it would be the ultimate environmental disaster. If the blast or heat or radioactive fallout does not kill you, the "nuclear winter" will.

Chemical weapons have been described as the poor man's nuclear bomb. Older, unitary munitions were particularly dangerous both to manufacture and to store. These older munitions could "leak", corrode their containers as well as degrade within their containers. Disposal of unitary munitions is problematic as the agents are particularly persistent. New binary munitions, however, are safe from manufacture to disposal as two nonlethal compounds are kept separate until weapon detonation on the target when the two mix to form a lethal compound.[72]

In addition to nuclear and chemical waste, the routine maintenance of military trucks, ships and aircraft annually yields more than 400,000 tons of toxic sludge, solvents, acids and heavy metals.[73]

From the Army perspective, environmental factors are having a potential negative impact on readiness. Realistic and continual training of Army forces is necessary to maintain the degree of readiness deemed sufficient to deter aggression, or to fight if required. Realistic training requires a force to train as it would fight. Ideally, this means that the force would

train on the terrain where it would most likely fight, using the full range of weapons in the (conventional) inventory, and maneuver in operational strength. The training would also be conducted at a tempo, and under realistic combat conditions such as night operations, to assure the maintenance of a maximum state of readiness.

The Army's ability to conduct this type of training, however, is becoming increasingly problematic. Training of this scale and intensity is not only very expensive in a period of declining defense budgets, but can also be very damaging to the environment. Environmental damage, depending on how liberally "damage" is defined, can result from most military activity. Principal public environmental objections to military training address noise, physical damage to fields and forests and intrusion on a peaceful lifestyle. Public interest groups and ordinary citizens, in the United States as well as overseas, increasingly are mounting strong opposition to military training on such environmental grounds. Current developments in Europe serve as an excellent example of the increasing difficulty facing the commander attempting to conduct realistic training.

In Europe, training is becoming more difficult as environmental concerns combine with changing threat perceptions and German political sensitivities leading to civilian opposition to military activity. The traditional German reverence for forests has been reawakened as acid rain is taking its toll and concern is mounting about the future of the

forests. "Green" political parties are emerging on a pro-environment, but anti-NATO and anti-military platform Many Germans now apparently have mixed feeling about the presence of U.S. forces on their soil. The "successor generation" did not experience the stressful and threatening events surrounding the Berlin Blockade or the construction of the Berlin Wall. Older Germans may be feeling "verteidigungsmudigkeit" - defense weariness. For many reason, German tolerance of military training activity has declined significantly over the past decade. Primary environmental complaints about U.S. forces in Germany include firing range noise, aircraft noise, night firing, highway and airway congestion and damage to farmlands and forests by maneuver forces. A vocal element of the German public is also opposed to new construction/expansion of training facilities on environmental grounds.

AirLand Battle, with its deep fires and Follow On Forces Attack doctrine, emphasizes mobility and depth. The introduction of the M2/3 Bradley, M1A1 tank, Apache and Blackhawk helicopters and the MLRS all facilitated greater mobility and operational maneuver. Existing training areas in Germany, however, are only marginally adequate in accommodating this wide-ranging AirLand doctrine. While the Status of Forces Agreement grants certain rights to U.S. commanders to train where and when needed, the realities of contemporary German society require that U.S. commanders consider German sensitivities. As a result, many de facto restrictions on

U.S. training have been imposed over the years.

Current political events in Europe, however, will probably change the training needs of U.S. forces in as yet undetermined ways. Substantial troop reductions on both sides of the inter-German border will lead to greater warning time of attack which, in turn, should lower the readiness requirement. The most recent understanding between the Soviet Union and the United States will limit both sides to 195,000 troops in the central region of Europe. To achieved this level, the U.S. will have to withdraw, for practical purposes, one of its two deployed corps. Far fewer forces, training at a lower operational tempo, should significantly reduce German opposition to training on the basis of environmental impact.

The reduction of a significant number of troops in Europe (and from other overseas locations such as Korea and Panama), however, means that a significant number of troops will be returned to the Unites States. This other side of the overseas troop reduction coin has many implications for the Army. A central concern must be what to do with the troops when they return home. If, as it appears, several hundred thousand troops return, additional facilities/installations must be established to accommodate them. This construction/expansion of facilities would be undertaken in the face of fiscal constraints and probable opposition from environmentalists. In a sense, there could be a repetition in the domestic arena of the military experience in Europe over the past decade. Existing facilities

would become overcrowded and new construction would encroach on surrounding communities, both factors provoking opposition on environmental grounds. An alternative scenario in response to these possible difficulties, as one of several suggested by Charles W. Taylor of the Army's Strategic Studies Institute (SSI), would have 30-40 percent of the returning units deactivated or assigned to the Reserves.[74] The Army Long-Range Planning Guidance (ALRPG) of June 1989 also points out that "fiscal constraints and environmental concerns ultimately have the potential to impair readiness into the next century."[75] These certainly are issues requiring timely consideration by the senior Army and Defense leadership.

The ALRGP also emphasizes the need for environmental considerations in planning for future Army force structure and doctrine. In discussing expected trends over the next thirty years, the ALRPG notes that:

> Environmental concerns will grow in importance over the planning period and will directly and indirectly affect the Army. As environmental clean-up and restoration rises in the public eye, this will become a major national priority placing further demands on Army resources. Four areas that will bring pressure to bear on U.S. security interests and the Army are: the interrelationship between environmental protection and economic development, especially in the Third World; trans-boundary pollution in the form of hazardous waste transport, air and waste pollution; global environmental phenomena such as climate change and sea rise that could cause significant population shifts or scarcity of food and water; and industrial emergencies and conflicts that cause significant or large scale contamination.[76]

The above four areas of environmental security interest basically parallel the findings of this paper. In considering

courses of action to address the above conditions, however, the ALRPG errs in confusing causes and affects. The ALRPG states that "Closely allied to the Army's deterrent role in LIC (Low Intensity Conflict) is the elimination of instability through security assistance and civic action. Maintaining appropriate levels of security assistance is critical to addressing the causes of instability."[77] The causes of instability are the plethora of economic, social and environmental factors which erode confidence in the government and force people to seek alternative solutions. The reality is that economic, social and political problems, many induced or exacerbated by environmental degradation, do not lend themselves to military solutions. Security assistance may help to control instability, but it does nothing for the causes.

One interesting school of thought suggests that military spending and programs, in the Third World in particular, are in fact part of the problem rather than part of the solution. Worldwatch Institute's Michael Renner notes that since World War II, governments of the world have spent $17.5 trillion for military purposes. While the vast majority of that money has been spent by the industrialized countries, billions have been spent by Third World countries least able to afford the expense. Scarce resources, which otherwise could be applied to stemming the ravages of environmental degradation, are spent for weapons ostensibly to defend against an external enemy. Renner points out, however, that the military institutions in many Third World

countries are used as "instruments for preserving political and economic structures that deny basic needs and opportunities to the majority."[78]

Military considerations as part of the security implications of environmental degradation are complex and wide-ranging. Factors ranging from nuclear weapons production to Third World security assistance programs fall within this broad category. The industrial base and processes required for the production of arms worldwide has contributed significantly to the pollution of the environment. Defense industries also draw heavily on nonrenewable resources to meet mineral as well as energy requirements. Resources used for military purposes are, by mutual exclusion, not available for application to social or environmental protection programs.

The military impact on the environment is also evident by the negative public reaction, particularly from Europeans, to military training activities involving noise, congestion and physical damage to fields and forests. Public opinion will be less willing to support environmentally detrimental military training activities, particularly when the need, based on threat perception, has diminished significantly. Readiness, as currently defined, must be reconsidered.

These changing environmental and threat perception factors will influence not only how the Army trains, but also the basic doctrine of defense. SSI's Taylor captured the magnitude and significance of the probable changes facing the U.S. military

establishment, even in the relatively short term, when he wrote that:

> ...U.S. national security threats by the year 2010 almost certainly will be different than those which confronted the United States in the 20th century. In all likelihood, the manner by which the nation confronts threats to its security and provides for its defense also will be different. Military traditionalists likely will have disappeared from the 2010 scene.[79]

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CHAPTER IV

WHAT NEEDS TO BE DONE?

Earth Day 1990 will be recognized on 22 April. It is estimated that at least 100 million people from more than 100 countries will take part that day in the largest global demonstration in history. One of the many activities planned will be a joint expedition by climbers from the U.S., China and the Soviet Union to the summit of Mount Everest to clean up debris left by previous expeditions. A bicycle procession is being organized by environmentalists in West Bengal, India. Trees will be planted by school children in the island nation of Mauritius in the Indian Ocean. Environmentalists in Seattle will demonstrate against pollution in Puget Sound. All this is being done with the hope that Earth Day 1990 will serve to galvanize public awareness of environmental problems and "...that it will change individual behavior and launch a decade of environmental activism."[1]

The universality of Earth Day 1990 is indicative of a worldwide awarenes and concern about the environment. In the Soviet Union, where severe environmental degradation has been an inevitable by-product of Socialist industrialization, in perhaps another manifestation of "new thinking", the Kremlin has recently organized a new State Committee for the Protection of the Environment, Goskompriroda. This new Soviet organization reflects the understanding that "...the Communist Party Central Committee has decided that, after disarmament, environmental protection is the No. 1 world isue."[2] Perhaps more important in

relation to current political developments in the Soviet Union. Marshall Goldman of the Russian Research Center at Harvard University noted that "In almost every republic in which there is a movement for independence or the assertion of political rights, it has been led by an environmental movement."[3]

The Green movement, particularly in Europe, is gaining momentum as environmental awareness and activism develops a political arm. Marlisa Simons, writing for the New York Times reported that the Greens;

> ... see themselves as part of a fast-growing movement that aims to occupy a firm place in European governments in the coming decade. Green issues, they note, have not only entered Europe's political vocabulary, but in the press, in parliamentary debate, in conversation, more people than ever are talking of an "eco-philosophy"...It means, Greens assert, that the public is beginning to understand that Green thinking is a world view and "not just a set of issues."[4]

In the United States, however, support of environmental issues is mixed at best. The Bush Administration seems to be having difficulty in coming to grips with the importance of environmental issues. On one hand, the Administration's environmental rhetoric is fairly strong, but environmental actions are not proportionate to the problem.

The summit meeting of the Group of Seven industrial democracies in Paris in July 1989 was an occasion for President Bush to demonstrate leadership in environmental issues. Almost one-third of the final communique was devoted to expressions of concern for the environment. William K. Reilly, Administrator of the Environmental Protection Agecny, was quoted as saying "The communique contained an unprecedented expression of urgency

and concern about the environment ...The meeting moved environmental concerns a long way from the periphery to the center of policy making."[5]

Perhaps consistant with this new centrality of environmental issues in the policy arena, President Bush announced in his State of the Union address the elevation of the Environmental Protection Agency to Cabinet rank, the provision of "...over $2 billion in new spending to protect our environment, with over 1$ billion for global-change research,...and money to plant a billion trees a year."[6] And most recently, a compromise on Clear Air legislation has been worked out between the Senate and the Administration which would control 187 toxic substances in the air as well as target a 40 percent reduction in sulfur dioxide emissions by the end of the decade.[7] These initiatives remain promises at this point, and, other than the Cabinet rank for the EPA, the Administration and the Congress will have to work out the specifics of legislation and funding to make them a reality.

The Administration's position on environmental issues in at least one less public arena, however, is totally lacking. A careful reading of an advance copy of the final draft of the 1990 National Security Strategy, prepared by the National Security Council staff for the President's signature, reveals there is no mention of the environment as a domestic concern or an international security issue. This 1990 position represents a significant change in national interests and strategy from those presented in the 1988 National Security Strategy

previously referenced in this paper. It remains to be seen if this omission in fact represents a conscious decision to change interests and priorities. The draft 1990 National Security Strategy, in its current state, is difficult to reconcile with the more public pronouncements of the Administration.

While the Bush Administration is deciding what to do about the environment, the multitude of environmental problems outlined in this paper continue to worsen. There is an obvious need for environmental action on a major scale. Resources and technologies are available as well as extensive literature with imaginative courses of action. Political will and committed leadership, however, appear at the moment to be the lacking ingredients. While the Administration has taken some small environmental steps, there remains much that needs to be done.

The population explosion will continue to be a major environmental problem for the foreseeable future. The current world population will almost certainly double by the latter half of the next century. Birth control remains a sensitive religious and cultural issue in many areas of the world, but renewed efforts must be made to limit the number of people born through education and medical technology. As noted throughout this paper, population is the root cause of environmental degradation. The first step in reversing the degradation is to lighten the population pressure on the fragile environment.

Education and increased public awareness are prerequisites for the establishment of effective and sustained environmental programs. There must be a universal recognition that all people

share the same earth and that "security" in the future cannot be viewed exclusively in military terms. One author, commenting on this need for a new view of security, wrote:

> Most world leaders nonetheless continue to accept the traditional definition of security based on military might. Yet the well-being of nations and their individual citizens depends as well on economic vitality, social justice, and ecological stability. Pursuing military security at the cost of these other factors is akin to dismantling a house to salvage materials to erect a fence around it.[8]

It is imperative, then, for societies to change or modify some of their preconceptions of world order as well as to develop more realistic expectations of what a finite world can provide. Worldwatch's Renner emphasizes that it must become understood that environmental degradation threatens nations' most fundamental basis of security by undermining the natural support system on which all human activity depends.[9]

Assuming a presence of public awareness and political will, much can be done immediately to slow or reverse the tide of environmental degradation. In the "Planet of the Year" issue, TIME magazine proposed a list of eight action items which would be a step in the right direction. This list included raising the gasoline tax, toughening auto fuel-efficiency requirements, encouraging waste recycling, promoting use of natural gas, encouraging debt-for-nature swaps, supporting family planning, ratifying the Law of the Sea, and making the environment a summit issue.[10] At least one these items, the environment as a summit issue, has become a reality. Recycling of waste is becoming a requirement in many communities. The majority of the other items on the list, however, are tied up in

economic or cultural considerations and will go nowhere without strong executive leadership.

One of the most frequently expressed concerns about attempting to reduce environmental degradation is the projected cost, and who should pay. One source estimates that:

> ...the global community would have to expend a cumulative sum of about $774 billion during the final decade of this century to turn around adverse trends in four priority areas: protecting topsoil on croplands from further erosion, reforesting the earth, raising energy efficiency, and developing renewable sources of energy. The sum is equivalent to just under 10 percent of annual world military spending.[11]

But $774 billion over ten years, however, is still a substantial amount of money. On the economic side, environmental decisions will be made when it is realized that it will cost more to operate inefficiently than to switch to high-efficiency technologies. Amory Lovins, director of research at the Rocky Mountain Institute has been quoted as saying "The technology exists today to save 75 percent of the electricity and 80 percent of the oil used in the United States without lowering our standard of living at all."[12]

By increasing the efficiency of current energy resources, not only will environmental pollution and greenhouse gases be reduced, but additional time will be gained to pursue the development of alternative energy resources.

Fusion would be the ultimate energy source. It generates no carbon dioxide and also does not produce radioactive waste. One cubic foot of sea water could furnish the energy in 10 tons of coal - and the supply of water would be inexhaustible.[13]

Another non-polluting energy alternative is wind power.

According to a study by the General Electric Space Division, if the United States were saturated with enough wind farms to take advantage of all the high-wind areas, the wind turbines could supply about 40 percent of the total U.S. electrical demand.[14]

Recent breakthroughs in the development of photovoltaics are increasing the commercial potential of solar energy. Sandia Laboratories recently achieved a record photovoltaic efficiency of 31 percent, still not enough to be competitive in the electric utility market, but showing promise.[15]

While technologies hold some promise in the battle against environmental degradation, the real environmental battle will be fought in overcoming nationalistic and self-serving interests. A major international efforts must be undertaken by the industrialized countries of the world to help the Third World, through transfer of technology, debt relief and other economic development assistance, cope with their problems of population, deforestation, desertification and pollution. The industrialized countries must also lead the way in working towards overcoming the problems of global warming and ozone depletion.

Unfortunately, organizations and structures to address environmental degradation problems are incipient at best. The most effective organization at the moment is the United Nations Environment Program (UNEP) which has been a leader in motivating and mobilizing the international community on environmental issues. Its most significant achievement to date is the 1987 Montreal Protocol that calls for a 50 percent cut in CFC production by 1998. While the UNEP is effective in this limited sense, there are still no overarching, firmly established

international mechanisms to address environmental problems.[16]

But out of the mess of environmental degradation, humanity has an opportunity to redirect efforts into new, constructive and beneficial endeavors. George Kennan recognized the type of potential which can emerge from international efforts to overcome common problems when he said that:

> ...in the very process of collaboration in a necessary and peaceful process, useful to all humanity, the neurotic impulses of military and political rivalry would be bound to be overshadowed; and the peoples might find, in the intermingling of their own creative efforts, a firmness of association which no other intergovernmental relationship could ever assure.[17]

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APPENDIX

A CLOSER LOOK AT ENVIRONMENTAL DEGRADATION

This appendix is provided for the reader who has a need or desire to gain a greater insight into specifics of environmental degradation. The appendix describes some observations and quantitative data which will sharpen the focus on discrete environmental elements, and at the same time demonstrate the interrelatedness of the issues. As noted in the introduction to this paper, a proper understanding of environmental degradation issues must be made within a systemic and holistic context rather than in discrete or isolated segments. For the purposes of clarity and simplicity, however, this closer look at major environmental degradation factors is presented in the following segmented sequence; population, global warming, ozone depletion, deforestation, desertification, pollution and reduction of biological diversity. The concluding section of the appendix provides opposing points of view from several experts in the field who do not believe the problems of environmental degradation are as severe or alarming as the majority opinion indicates.

POPULATION

World population projection figures are frightening. Thomas Malthus, in publishing an essay in 1830, was concerned by

what he saw as adverse effects of England's rapid population expansion. In essence, Malthus said that unchecked, populations tend to grow in a geometric progression and at a rate that would double the numbers about every twenty-five years. Food supplies at best, he thought, could increase in arithmetic progression. The superior power of population growth over the means of subsistance required that population growth would inevitably be checked, if not by preventative measures, than by the positive inroads of starvation, disease, war, etc. which he grouped under the heading of misery and vice.[1] The benefits of the Industrial Revolution, however, largely offset Malthus' dire predictions. Economic expansion and technological development required a labor pool, and the pool became the market for the products of industry.[2] Malthus' hypothesis seemed to have been proven wrong. But now, as we prepare to enter the 21th century, the reality of the dire Malthusian population hypothesis seems to be reasserting itself on an ill-prepared world.

Considering a 1982 baseline, the world population grew by 2.5 people every second, the consequesces of 4.15 births and 1.65 deaths every second. Projecting this rate of increase out over time shows that 150 people would by added to the earth every minute, 9,038 people per hour, 216,916 people per day. 6,597,858 people per month, for a total of 79,174,297 people per year in 1982.[3] Statistics for 1989 indicate the population of earth is now approximately 5.2 billion, which includes an increase of about 87.5 million during the year. At this current

rate of increase, the population of the earth could double as early as 2025.[4]

Of course, these aggregate population numbers are only abstractions. The numbers must be put into context to become meaningful. The fact that the earth is physically finite seems to elude some of the people who doubt there is a developing population crisis. One way to put the population situation into perspective is to consider that the sphere of the earth has a surface area of only 196,940,000 square miles. Most of this area, however, is covered by oceans. The total land area of earth is only 60 million square miles, and 2/3 of that land area is unsuitable for settlement.[5] If we accept the current world population as approximately 5.2 billion, and place all these people on the 20 million square miles of habitable land, we find that at this point in time we have a theoretical population density of 260 people per square mile. While this theoretical density assumes a uniform distribution, the reality of world population distribution is anything but uniform. In fact, central to the point of this paper is the reality that due to population asymmetries in many parts of the world, people are destroying previously habitable land while at the same time are being forced further onto marginal or uninhabitable land and urban areas.

As noted earlier, 90 percent of the increase in world population over the next century will occur in the less developed areas of the world, principally Latin America,

Sub-Saharan Africa and Asia. These are areas least able to accommodate dramatic population growth.

Latin America had a population of only 165 million in 1950 but grew to 405 million by 1985, representing an annual growth rate during the period of about 2.5 percent.[6] At this rate of growth, based on current age structure, fertility and mortality, the population of Latin America will reach 779 million in 2025, nearly double the present population.[7] Due to factors previously described in this paper under the heading of Social Considerations in Chapter III, many of these people will attempt to settle in urban regions. The trend is already well under way. Mexico City with 20 million residents, up from 9 million only 20 years ago, is considered the most populous urban center on earth.[8]

Sub-Sahara Africa is a special case. To quote Thomas J. Goliber of The Futures Group of Washington, DC,:

> Africa south of the Sahara, that huge region of vast geographical and cultural diversity, is home to what was estimated for mid-1984 as at least 434 million of the world's inhabitants. Birth rates are collectively the world's highest and, unlike the rates in other developing regions, shows no sign of falling. Death rates, however, are falling, though still high. As a result, population growth - at over 3% a year - is the highest of any region on earth, and rising. The most likely course of events, according to United Nations projections, is that more than a billion persons will be added to the region's population over just the 45 years from 1980 to 2025.[9]

Further, and more specifically, during the next 30 years the population of Kenya, with an annual growth rate of 4 percent, will jump from 23 million to 79 million. Within that same

timeframe, Nigeria's population, with a 3 percent growth rate, will expand from 112 million to 274 million.[10]

Asia, traditionally the area of the world with the largest populations, continues to grow at significant rates although somewhat slower than Latin America and Sub-Saharan Africa. While the rates are lower, however, the population base is of such size that even small growth results in some very large numbers. In 1985, Asia (minus Japan), with 2.7 billion people, held 55.8 percent of the world population. By 2025, this Asian region will grow by 1.7 billion people with the resultant total population of approximately 4.4 billion.[11]

China, with 21 percent of the world's total population in 1985, has been quite successful in slowing its rate of growth through education, the provision of major government family planning services and an enforced government policy of strictly limited family size. But even with massive government intervention, China grew by 1 percent, or 9 million per year, in the mid-1980s.[12] India, on the other hand, has not been nearly as succesful as China in controlling population. With an annual growth rate of 2.1 percent, India is adding 16 million people annually, and will overtake China as the world's most populous country by 2020.[13]

The above population figures and projections have frightening implications for the future. Accepting as a given that the earth ultimately has a finite capability to sustain life, we are now reaching a point where the life support system

of earth is threatened. Up to this point in time, the earth has been able to accommodate reluctantly the ravages of man's exploitation of renewable and nonrenewable resources, much in the name of economic development. But with the huge and projected growth of populations, the ability of earth to continue to provide a habitat for man is seriously in doubt. We find ourselves in a paradoxical situation where vast numbers of people, in order to survive, are destroying the very environment they need to survive. This phenomenon is not limited to the demands of a minimum agrarian substance in the Third World. In the developed world, the demands of industrial societies are taxing the earth's resources to an unprecedented and disproportionate degree. The implications of population growth and concomitant environmental degradation affect everyone.

GLOBAL WARMING

On 23 June, 1988, James E. Hansen, director of NASA's Goddard Institute for Space Science Studies testified before the Senate Energy and Natural Resources Committee. The bottom line of his testimony was that "Global Warming has begun." What is significant in this statement is that "Hansen brought to public attention what is now a strong and largely undisputed consensus of atmospheric scientists: global temperatures are almost certain to warm rapidly during the coming decades, posing a serious threat to societies and ecosystems throughout the

world."[14]

The problem of global warming is caused by man's upsetting the delicate balance of nature's greenhouse effect. The greenhouse effect is the phenomenon that keeps the earth warm, and therefore habitable, because of the heat-trapping ability of certain atmospheric gasses, particularly carbon dioxide, methane, nitrous oxide and chloroflurocarbons (CFCs).[15] Historically, carbon dioxide and methane found in nature have provided the relative temperature stability to allow life to flourish on earth. With the significant increase in fossil fuel (coal, oil and gas) energy consumption required to drive the Industrial Revolution and increased energy needs of the rapidly expanding populations, however, the concentration of both carbon dioxide and methane in the atmosphere began to increase. Christopher Flavin of the Worldwatch Institute of Washington D.C. notes that the world energy system is now responsible for more than half of the greenhouse effect through the release of at least 21 billion tons of carbon dioxide to the atmosphere annually, as well as methane and nitrous oxide. He further states that carbon-containing fuels provide almost four-fifths of the world's energy; their use continues to grow 3 percent annually; the increase in carbon dioxide concentration in the last 30 years exceeds that in the previous two centuries; the gas has reached its highest level in 160,000 years; and if the use of fossil fuels continues to grow, the earth will become uninhabitable long before all the earth's fuel reserves are

exhausted.[16]

If the rate of increase of "greenhouse" gases in the atmosphere continues as predicted, we can expect appreciable warming of the earth by between 1.4 and 4.2 degrees Celsius by the middle of the next century.[17] The affects of a temperature increase of this magnitude within this relatively short time will significantly disrupt the climate and ecosystems of the earth. Forests and agricultural regions, for example, are adapted to relatively narrow temperature and moisture ranges. Ecologist Margaret Davis has modeled the impact of global warming on the forests of the eastern United States. Her findings suggest there will be a northward shift of growing conditions of 500 - 1,000 kilometers by mid-century, giving Maine the climate of Georgia.[18] But the problem is that trees and their associated ecosystems simply cannot migrate that far in a few decades.[19]

Shifting temperature zones will also cause shifts in climate zones by affecting winds and the distribution of moisture. NASA's Hansen predicts that as early as 2030, the odds for severe summer droughts in the middle and lower latitudes of Earth would rise to one-in-three, in contrast to the one-in-twenty odds characteristic of the 1950s.[20]

In addition to major shifting of growing regions, "global warming" will warm the oceans and result in both thermal expansion of the water and significant melting of the polar icecaps. By the end of the next century, the seas may be up by

about 1 to 2 meters.[21] At this new level in the year 2100, for example, over 38 million of the inhabitants of Bangladesh would be forced to relocate due to coastal flooding.[22] Warmer oceans will also increase the probability and severity of major storms. Storms will be 40 to 50 percent more energetic than present ones, with potential for the generation of hurricanes with winds up to 225 mph.[23]

Global warming is going to change the world we live in. The warming will probably occur at a rate and of a magnitude which will severly tax our ability to adapt. Worldwatch's Flavin has written that "Changes to the earth's atmosphere...are global and - for all practical purposes - irreversible not only in our lifetimes but in our children's and grandchildren's as well."[24]

OZONE DEPLETION

Ozone is a gas found naturally in the atmosphere. It is concentrated in the stratosphere in a layer between 10 and 30 miles in altitude. It has been found that ozone molecules absorb most of the ultraviolet radiation that comes from the sun - this is particularly significant as ultraviolet radiation is extremely dangerous to life on earth.[25]

Man, however, inadvertently began to interfere with the ozone layer when he first synthesized chlorofluorocarbons (CFCs) in the late 1920s. CFCs are relatively cheap to manufacture and

have been used extensively as refrigerants, propellants for spray cans and in the manufacture of insulating foams like "Styrofoam". When initially tested, CFCs were found to be nontoxic and inert and, therefore, safe for use.[26]

What was not understood initially was the devastating affect of CFCs on the atmosphere. When a CFC molecule eventually breaks down, each atom of chlorine released can break up as many as 100,000 molecules of ozone.[27] Meanwhile, there is a sixty-year accumulation of CFCs in the atmosphere where many will remain for 60 to 120 years. And they presently are increasing at a rate of 5 percent per year.[28]

The destruction of ozone by CFCs, therefore, allows harmful levels of ultraviolet radiation from the sun to reach the surface of the earth. Research has shown that this radiation can be linked to the formation of cateracts as well as the weakening of the immune systems of man and other animals. It has also been found that ultraviolet radiation can damage DNA in the cellular structure of tissue, which suggests that sunlight is a primary cause of some forms of skin cancer.[29]

In addition to the problems caused by the CFC erosion of the ozone layer is the contribution CFCs make to the global warming phenomenon. CFCs, like carbon dioxide and methane help to prevent the escape of heat though the atmosphere. But while they are present in only minuscule quantities (200 to 400 parts per trillion) each CFC molecule is 10,000 times as efficient trapping heat as a carbon dioxide molecule.[30]

Compared to other environmental degradation elements, ozone depletion, while harmful to both man and the environment, should probably be considered to be in the lower half on a scale of rank ordering. It is a contributing factor to overall global warming, but relatively insignificant compared to carbon dioxide and methane. The affects of ultraviolet radiation on living organisms, while a concern, does not presently appear to have the potential to cause major problems for mankind. Of course, there may be some long-term affects of ozone depletion which are unknown at this time.

DEFORESTATION

Tropical rain forests in Latin America, Asia and Africa are being destroyed at a rate of 28 million acres a year - an area the size of Pennsylvania.[31] As noted earlier, The Global 2000 Report to the President predicted that by the year 2000, 40 percent of the earth's remaining forests may disappear. This destruction is almost exclusively the direct result of pressures from expanding populations and the perceived needs for economic exploitation. The causes, or justifications, for forest destruction include "expanding and shifting agriculture, spontaneous settlement, planned colonization, clearance for plantations and ranching, and cutting for fuel and logging."[32]

Many interrelated environmental problems are created by the destruction of the tropical forests. In order to clear tropical

forest land for agricultural or ranching, the preferred method has been by burning. In one frightening example, a purposefully set fire in 1988 in the Brazilian state of Rondonia destroyed an estimated 12,350 square miles of rain forest - an area larger than Belgium.[33] One of the major byproducts of massive forest burning is increased carbon dioxide in the atmosphere. In fact, in many developing countries, deforestation is adding more carbon dioxide to the atmosphere than fossil fuel combustion. Using Brazil as an example again, it is adding an estimated 336 million tons of carbon to the atmosphere each year due to deforestation - over six times as much as from Brazilian fossil fuel combustion.[34]

Burning or otherwise clearing of the tropical forests, however, is only the beginning in destabilizing the delicate ecological balance. One result is the disruption of the water supply. In one study where twenty-four developing countries had experienced heavy forest losses, a critical water shortage appeared in sixteen of them and increased flooding occurred in ten.[35] The acreage gained by deforestation frequently is unsuitable for agriculture as it tends to be poor in nutrients and is highly subject to erosion.[36]

Another obvious and direct result of deforestation is the removal of millions of trees which otherwise would be using the process of photosynthesis to remove carbon dioxide from the atmosphere. By burning forests, therefore, the net result compounds the global warming problem by adding carbon dioxide to

the atmosphere, and at the same time, seriously degrading the earth's capability to remove carbon dioxide.

Perhaps less obvious but also of major significance is the production of methane in deforested areas. Methane was noted earlier as a significant "greenhouse" gas. In fact, it is 25 times more efficient than carbon dioxide in absorbing infrared radiation and remains in the atmosphere for about ten years.[37] Methane in the atmosphere can come from many sources, but in deforested areas, termites, living in destroyed trees, break down cellulose through an anaerobic process and produce methane. One study suggested that, on a worldwide basis, termites could be responsible for the production of 150 million tons of methane a year.[38] Ranching, one of the often declared justifications for deforestation, also produces methane. The digestive process of cattle produces an estimated 400 liters of methane per head per day. Considering there are about 1.2 billion head of cattle on earth, they contribute about 100 million tons of methane to the atmosphere each year.[39]

When the forests can no longer serve as stabilizers, the interrelatedness of environmental degradation becomes apparent. The current situation in Bangladesh serves as an excellent example. Deforestation of the slopes of the Himalayan mountains causes massive runoff of monsoon rains down the Brahmaputra and Ganges Rivers. At the same time, the deforested areas no longer have the capability to remove carbon dioxide from the atmosphere, thereby adding to the global warming trend. Global

warming, as noted earlier, results in the rise of sea level as well as an increase in intensity and frequency of major storms. Add to this equation the massive increase in population expected in Bangladesh over the near term, and the net result is unmitigated disaster. August of 1988 seems to portend the type of future Bangladesh can expect.

> In late August Bangladesh is inundated by a massive flood that drowns almost 80% of its land. More than 25 million people lose their homes and are driven to wade through swirling polluted waters, with the inevitable results of cholera and dysentery epidemics. More than 1,200 people are killed outright. Bangladesh used to be savaged by such monsters about once in 50 years. But since 1980 there have been five "50-year" floods, each more punishing than the last.[40]

DESERTIFICATION

Deforestation is, to a great extent, an expression of desperation on the part of expanding populations attempting to survive by clearing "new" land for agriculture and acquiring fuel wood for cooking and warmth. Areas such as the slopes of the Himalayan Mountains and much of the Amazon Basin are not suited to agriculture, and the land is soon exhausted. Desertification represents, in many instances, the final stage of deforestation.

Desertification is the human destruction of land to the point where it will no longer support agriculture or even grazing. While long term climate shifts resulting from global warming will eventually have some impact on the development or

shifting of arid regions, desertification, within the present context, refers to that caused directly by man.

In 1980, it had been estimated that the desertification process was impacting on vast areas of the world. The areas affected in 1980 included 27 million hectares of irrigated land. 173 million hectares of rainfed cropland and 3,071 million hectares of rangeland.[41] Another study, in 1986, indicated that twenty million hectares stopped being productive annually as a result of desertification.[42] Desertification comes down to overcultivation, overgrazing or salinization resulting from encroaching sea water and/or irrigation without adequate drainage.

The root cause of desertification is population presure on the finite availability of arable land. A 1982 study estimated that there was, at that time, approximately 14 million square kilometers of cropland in the world. It was further suggested that within 20 years, if the current rate of desertification and shifts to nonagricultural use continued, one-third of the arable land on the earth would be lost.[43] In addition to losses due to exhaustion and urban sprawl, erosion of soil also takes a significant toll. Soil is, for practical purposes, a nonrenewable resource. Nature requires from 100 to 400 years to produce 10 millimeters of top soil, and 3,000 to 12,000 years to produce about eight inches.[44]

Thomas J. Goliber, of the Futures Group of Washington DC. expressed the desertification problems being experienced in

Sub-Saharan Africa as follows;

> Tradition-bound agricultural practices keep productivity low. A plot of land is cultivated, then left fallow while other plots are cultivated. . . . The system of shifting cultivation has long been based on an abundance of productive land. But with population pressures, land is now scarcer in some parts of the continent and more marginal, less productive lands are brought into cultivation. Fallow periods have been shortened to one or two years, not enough for recouperation of the land. Productivity is further reduced by erosion in the most intensively cultivated lands which allows topsoil, seeds and water to escape when rains do come.[45]

This degradation of the soil, however, is not limited to farming. As human populations increase, the population of their livestock also increases. Overgrazing of marginal lands contributes significantly to desertification. The U.N. Environmental Program estimates that a combination of overgrazing, deforestation and poor farming practices is turning 24,000 square miles of African land into desert each year.[46]

While the affects of desertification are particularly dramatic in Africa, the process is ongoing worldwide. Of course, the problem is that at the very time populations, and the concomitant requirement to feed, fuel and shelter the populations, are skyrocketing, the amount of land available for agriculture and grazing is being significantly reduced in both area and productivity. It is in the less developed areas of the world where this affect of environmental degradation is most keenly felt. In these areas the earth's capacity to support life is being seriously damaged by the efforts of the present population to meet desperate immediate needs with marginal or

practically nonexistent resources. The question of what resources future generations will have available to them remains open.

POLLUTION

The term "pollution" can apply to a wide range of environmentally detrimental contributors. A dictionary describes pollution as "The contamination of soil, water, or the atmosphere by the discharge of harmful substances."[47] The previous discussion of the emission into the atmosphere of carbon dioxide and other "greenhouse" gases such as CFCs certainly falls within this definition of pollution. This section also addresses some of the broader aspects of chemical and nuclear pollution as well as the problems of toxic waste and solid waste disposal.

The use of chemicals has been closely tied to the development of contemporary industrial societies. In 1982, it was estimated that there were 70,000 chemical compounds on worldwide commercial markets. At that time, it was also estimated that 1,000 new chemicals entered the markets each year.[48] In spite of hopefully rigorous testing of new chemicals, there is little or no knowledge of their potential long-range effects. The previous examples of the use of CFCs and their impact on the ozone layer, and the hazards found in the use of DDT, as described in Rachel Carson's Silent Spring,

should make that point.

Potentially dangerous new chemical compounds, however, are only part of a much larger chemical pollution problem. In addition to carbon dioxide, other products of the combustion of fossil fuels include sulpher and nitrogen oxides. Predominantly emitted by power plants, smelting industries and motor vehicle exhaust, these particular compounds are converted to sulphates and nitrates by chemical reactions in the atmosphere, where they can drift for hundreds of miles.[49] While these chemicals can precipitate from the atmosphere in a solid form, they fall most frequently as "acid rain".[50]

While precipitation is normally slightly acidic, the large amounts of acid-producing sulpher dioxide emitted into the atmosphere causes widespread environmental damage. In 1985, the United States alone produced about 27 million tons of sulpher dioxide, with about 15.8 million tons of the total coming from electrical power plants. By 1995, it is estimated that U.S. electrical power plants will be producing 18.5 million tons of sulpher dioxide.[51] To put acid rain into context, Wheeling, West Virginia once had a rainfall with a pH of 1.5 - the same acidity as battery acid.[52]

The environmental damage from acid rain is widespread and devastating, affecting ecosystems and man-made objects alike. The corrosive impact of acid rain on monuments, buildings and works of art is well known. The affect of acid rain on bodies of water and forests is particularly significant. The Office of

Technology Assessment of the U.S. Congress has estimated that about 3,000 lakes and 20,000 miles of rivers in the eastern United States are already, or are becoming, acidic with the concommitant loss of aquatic life.[53] Millions of acres of forests are also being damaged. The winds which carry sulpher dioxide emissions from the industrial heartland of the United States do not stop at our international border but continue spreading damage into Canada and over the ocean.

In Eastern Europe acid rain and other toxic industrial emissions have already destroyed vast forest regions, have polluted water supplies and have caused serious health problems among the population. James Bovard, writing in the New York Times, described what others have called an environmental "nightmare" or "wasteland" after visiting Eastern Europe in early 1987. He wrote that:

> In East Germany...90% of the trees are sick, dead or dying. The human mortality rate has increased sharply in Hungary. Poland, Russia and Bulgaria, and environment-related illnesses such as cancers and skin and heart diseases are soaring in all Eastern bloc countries. ...In Prague, mothers are advised not to give their babies tap water - even after boiling it. In northern Bohemia, the most heavily industrialized area of Czechoslovakia, life expectancy is up to 10 years shorter than elsewhere in the country. Rates for skin cancer, stomach cancer and mental illness are twice or higher than in the rest of the country. ...The Erzgebirge mountains along the Czech-East German border are rapidly becoming a huge tree cemetery the world's best showcase of the effects of acid rain. The higher one travels up the mountains, the worse the forest carnage. At the top of some mountains, not a single tree survives - just barren landscape with a few remaining stumps.[54]

Granted, the severity of Eastern Europe's acid rain and toxic

pollution problems are catastrophic due to unregulated industrialization under "Socialism", but the types of problems Eastern Europe is experiencing are not isolated or restricted to that region. As long as industrialized or industrializing societies rely on fossil fuels for energy, the specter of environmental disaster is omnipresent.

The interrelatedness of acid rain with other environmental degradation contributors becomes apparent when we recall the dynamics of global warming. The combustion of fossil fuels releases not only carbon dioxide - the major "greenhouse" gas, but also the chemicals which precipitate as acid rain. The acid rain then destroys forests which are critically needed to help reduce the amount of carbon dioxide in the atmosphere through photosynthesis.

Acid rain, however, is only one of many chemical polluters of the environment. Some of the other offenders include sewage, agricultural chemicals such as fertilizers and pestacides, oil, and metals. The unregulated dumping of waste from industrial processing can result in acids and metals contaminating soils, groundwater supplies and streams. In some cases, for example, mercury levels have been found to be so high in shellfish and tuna fish that they were unsuitable as human food.[55] Another example is the "Exxon Valdez" disaster in Alaska's Prince William Sound in March of 1989. The 262,000 barrels of crude oil which spilled from the ruptured hull of the tanker fouled the beaches and destroyed much of the wildlife in the area.[56]

Further out at sea, however, oil tankers routinely flush out their storage tanks, further contaminating and upsetting the delicate ecological balance of the oceans. This is just one of the many forms of dumping of toxic waste which is poisoning the environment.

Americans are among the worst polluters in the world when one considers the sheer magnitude of waste generated in pursuit of our lifestyle. In the "Planet of the Year" issue of TIME magazine, it was reported that:

> Each year Americans throw away 16 billion disposal diapers, 1.6 billion pens, 2 billion razors and blades and 220 million tires. They discard enough aluminum to rebuild the entire U.S. commercial airline fleet every three months. ...In the U.S. 80% of solid waste is now dumped into 6,000 landfills. Their number is shrinking fast: in the past five years, 3,000 dumps have been closed; by 1993 some 2,000 more will be filled to the brim and shut.[57]

In addition to the sheer volume of solid waste, the problem of toxic waste has even more serious implications for environmental degradation. The United States has only 5 percent of the world's population, but it disposes of 290 million tons of toxic waste each year. Of that annual 290 million tons. the routine maintenance of U.S. military trucks, ships and aircraft yields more than 400,000 tons of toxic sludge, solvents, acids and heavy metals.[58]

The problem, of course, is what to do with the toxic materials. The "not in my backyard" syndrome and the growing cost of treatment, storage and disposal of toxic waste provides a strong incentive to "export" waste for treatment or disposal

to other regions or countries where environmental awareness and/or regulations are weak or non-existant.[59]

The recent Pelicano case is an example of the type of toxic waste problem which will probably occur with much more frequency in the future. The freighter Pelicano was loaded with 14,000 tons of toxic incinerator ash in Philadelphia in September 1986. For over two years the ship sailed from one part of the world to another, looking for a port which would accept its toxic cargo. Permission to unload was denied at every stop. Reportedly, the Pelicano dumped 4,000 lbs. of toxic ash off the coast of Haiti in October 1988. A month later, the ship, now empty, appeared in the vicinity of Singapore. The ship's captain refused to reveal how or where he "unloaded" his cargo.[60]

Perhaps the ultimate form of toxic waste is nuclear material. Nuclear waste is an inevitable by-product of nuclear energy use for electrical power generation and ship propulsion as well as medical and industrial applications. Coping with nuclear waste is particularly difficult because it remains radioactive for up to 3 million years and its storage requires heavy shielding to contain harmful levels of radioactivity.[61] Nuclear and chemical waste from the production of nuclear weapons, however, can be an environmental disaster in its own right. Philip Shabecoff, writing in the New York Times about some of the worst environmental problems of 1988, noted that:

> Four decades of nuclear weapons production has polluted the air, soil and water at 16 plants and research laboratories

> in the United States. The contaminants include uranium, plutonium, cesium, strontium, PCB's, chromium, arsenic, mercury and solvents used in making nuclear weapons. Carcinogens leaking into an underground water reservoir from the Rocky Flates Plant north of Denver was ranked as the worst problem.[62]

The United States, of course, is only one of several countries in the world producing nuclear weapons with its concomitant highly toxic waste,

Nuclear accidents are another source of environmental degradation. The explosion of one of the reactors and the resulting release of massive amounts of radiation at the Soviet Chernobyl electrical power plant in 1986 is but one of the more dramatic examples of the potential for ecological disaster. Within four days of that accident, radiation levels in the city of Kiev (population 2.6 million) had risen to 100 times the safe level. To this day there remain major medical problems among those exposed to the Chernobyl radiation, while in some areas food is being grown in soil still contaminated by the radiation.[63] In the United States, the meltdown of a reactor core in the Three Mile Island nuclear power plant had the potential for widespread disaster.

In this instance, humanity finds itself on the horns of a dilemma. On the one hand, the harmful affects of the combustion of fossil fuels on the environment are well known, but on the other hand, the readily available non-fossil fuel, nucler energy, also has serious environmental considerations. Various alternative energy sources, with possible major application in the next century, are described in Chapter IV of this paper.

For the immediate future, however, nuclear energy, with its persistent and highly "toxic" waste, will remain a problem.

This discussion of some of the more obvious environmental pollution factors demonstrates both the magnitude and extent of permeation of pollution through earth's life support system. As populations and industrialization continue to spread through both advanced and developing societies, the inevitable by-product - pollution - will increasingly poison the environment and degrade the quality of life. Further, the negative impact of pollution, in conjunction with deforestation and desertification, on the earth's delicate ecological balance is still not fully understood. Investigation suggests, however that irreparable harm has already occured.

REDUCTION OF BIOLOGICAL DIVERSITY

An oil spill from an ocean-going tanker, the discharge of toxic industrial waste into the air or water, or deforestation of vast tracts of tropical jungle are obvious evidence of environmental degradation. Not so obvious, however, is one of the more far reaching and potentially most damaging results of environmental degradation - the reduction of biological diversity.

The term "biological diversity" covers both genetic diversity (the variability within a given species) and ecological diversity (the number of species within a given

habitat).[64] Over the four billion years of evolution of life on earth, an incredible variety of life forms developed. A 1982 U.S. National Academy of Sciences report estimated that a typical 4-square-mile area of tropical rain forest may contain 750 species of trees, 125 kinds of mammals, 400 types of birds 100 types of reptiles and 60 varieties of amphibians. In addition, each species of tree may support more then 400 insect species.[65]

This rich variety of life forms provides a pool of genetic resources which man has been able to utilize to improve his own quality of life. The development of new strains of crops with greater yield, improved quality and greater resistance to disease and pests has been one of the spectacular results of agricultural research. More than 70 percent of the crops produced in the United States are estimated to be based on plant species originating outside the country.[66] Research is also discovering that some chemicals found in nature can replace dangerous synthetic pesticides.[67]

Another area benefiting heavily from biological diversity is the production of medicines and other pharmaceutical products. One estimate indicates that more than 40 percent of the prescriptions dispensed in the U.S. contain a drug of natural origin (25 percent from higher plants, 3 percent from animals and 13 percent from microbes) as the sole active ingredient or as one of the principal ones.[68] The Squibb pharmaceutical firm, for example, used the venom of the

Brazilian pit viper to develop "Capoten", a drug for treatment of high blood pressure.[69]

While the toxicity of some forms of pollution can poison and destroy some species, the paramount threat to biological diversity is man's destruction of the life form habitats, especially wetlands and forests. Tropical forests cover only 7 percent of the earth's surface, but they house between 50 to 80 percent of the earth's species.[70] As noted in the discussion of deforestation in this appendix, the tropical rain forests of Latin America, Asia and Africa are being destroyed at a rate of 28 million acres a year - an area the size of Pennsylvania.

What is particularly unfortunate is that at the very time when the scientific tools are becoming available to more efficiently catalogue life forms and to understand their genetic composition, the life forms are being driven to extinction. At this point in time, only about 1.7 million of the earth's estimated 5 million to 30 million different life forms have been documented.[71] But at the earth's current rate and extent of environmental degradation, one estimate suggests that over the next two decades, as much as 10 percent or more of all species on earth could become extinct.[72] Of course, extinction of species, such as the large dinosaurs, has been part of the natural order of evolution. The present rate of extinction, however, is at least 1,000 times the pace that has prevailed since prehistory.[73]

Perhaps the most pronounced potentially negative impact of

the reduction of biological diversity is the possibility that among those species which have, or will have, disappeared from the earth are key ingredients for medical or agricultural breakthroughs. The expanding population, particularly in the Third World, living increasingly on the margin of survival, needs all the help it can get. It is ironic that perhaps the key to the future is being destroyed by man's current destruction of a significant portion of earth's biological diversity.

AN ALTERNATIVE POINT OF VIEW

This paper has attempted to document and describe several of the factors considered by many to be significant contributors to the phenomenon of environmental degradation. While the evidence of cause and effect may appear to be incontrovertible, there is in fact an alternative school of thought which believes environmentalists both exaggerate the dangers humans pose to the environment, and underestimate the resilience of nature. While there seems to be little dispute over the actual physics of environmental interaction, questions have been raised about the relative significance of human intervention with the planet's ecosystems.

Addressing toxic waste and pollution, Bruce Ames, a biologist at the University of California at Berkeley, believes that obsessive concern with cancer-causing chemicals in foods,

pesticides and toxic waste has produced convoluted regulatory attempts by the EPA and a superfluous Superfund to clean up dump sites. He further contends that government restrictions on man-made chemicals are absurdly stringent in proportion to their risk. Ames' bottom line is "Eating vegetables and lowering fat intake will do more to reduce cancer than eliminating pollutants."[74]

Perhaps the most controversial aspect of environmental degradation is the concept of global warming. Dixy Lee Ray, the former chairman of the Atomic Energy Commission and governor of Washington state, wrote an article in the conservative Policy Review in which she strongly refutes the significance of man's influence on the earth's greenhouse effect. She points out that the quantities of air-polluting materials produced by man during his entire existence on earth does not begin to equal the quantities of toxic gasses and particulates thrown into the atmosphere by just three volcanic eruptions: Krakatau in Indonesia in 1883, Mount Katmai in Alaska in 1912, and Hekla in Iceland in 1947. She acknowledges the 25 percent increase in carbon dioxide in the atmosphere since the Industrial Revolution (much perhaps contributed by the three referenced volcanic eruptions), but points out that according to the leading computer models of climatologists, the 25 percent rise in carbon dioxide should have caused measurable warming of 1 to 5 degrees Celsius - but it did not. Instead, the actual warming has been in the range of 0.3 to 0.7 degrees Celsius.[75] Andrew Solow, a

statistician at the Woods Hole Oceanographic Institution agrees that the computer models are weak. While recognizing the common understanding of the greenhouse effect, he believes that "...to say almost anything about timing, the magnitude of change or its geographic distribution is more than we can do."[76]

Another possible contributor to global warming has been described by John Eddy of the National Center for Atmospheric Research. He found what appears to be a correlation between decades of low sunspot activity and cold periods on earth, and high sunspot activity with periods of warmer temperatures. According to Eddy, the high solar activity of the mid-20th century could account for the period's relative warmth.[77]

If in fact the global temperature should rise by 1.5 to 4.5 degrees Celsius over the next 50 years as environmentalists have predicted, some in the alternative point of view school do not see this as catastrophic. Dixy Lee Ray suggests that while a warmer earth would cause shifts in agricultural patterns, with some areas becoming more fertile and other areas becoming less fertile, this would require some adjustments but would not be a disaster. She further contends that a sea level rise of 1.5 to 4.5 feet from thermal expansion and melting of the polar caps would cause a number of cities to be vulnerable to flooding, but only to the extent that Venice and Holland have coped with for centuries. These developments would be an "inconvenience" but not "apocalyptic".[78]

Achieving absolute scientific certainty and understanding

of the highly complex interaction between man and his environment may not be possible. As long as there is a degree of uncertainty about causes and effects, there will be a debate about what needs to be done, if anything, about environmental degradation. Assuming there is a problem, corrective action will have a heavy price. While the debate goes on, the realities and affects of environmental degradation plague the earth and its teeming billions of inhabitants today.

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